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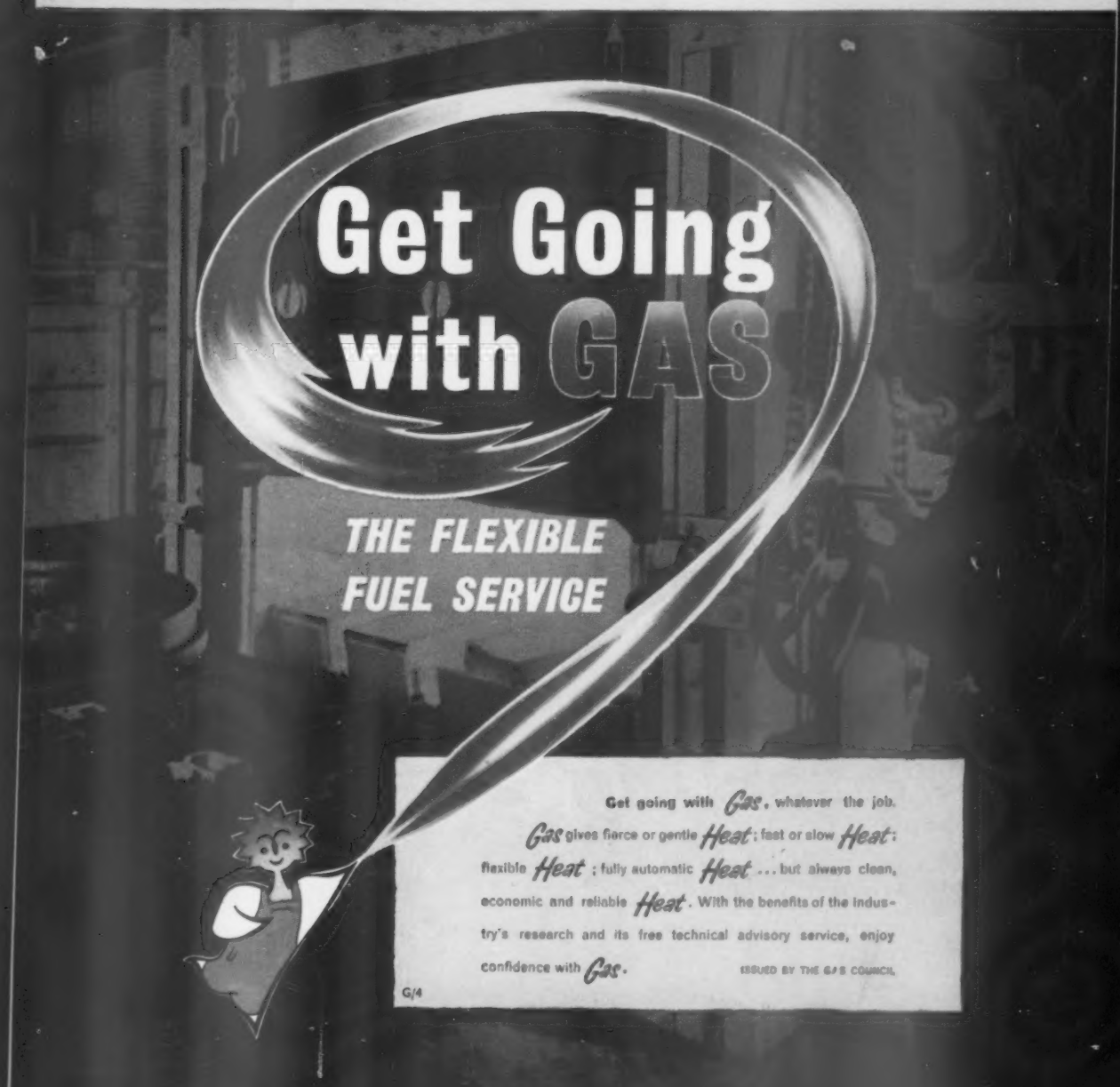
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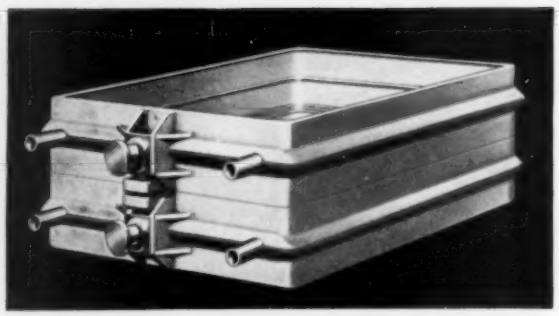

Sooner or later you will invest in Sterling moulding boxes because Sterling give you what you want. It is always possible to buy something a little cheaper but experience teaches that the best is the cheapest in the long run and there is no doubt that Sterling boxes are the best. Sterling were in the forefront fifty years ago. Fifty years of effort have maintained them there. Sterling keep ahead of the job, like only a leader can.

★ *Sterling have technical staff always available to discuss the best box for your particular needs, and this Sterling service is world-wide. Sterling representatives will be pleased to call at your request.*

Sterling Boxes are Light, Accurate, Durable, Strong and Interchangeable. They are made in a wide range of sizes from 9ins. square to anything up to around 14ft. in width to around 27ft. in length for special requirements.
Sterling boxes are made for bench moulding of the simplest kind to the most highly mechanised foundries using the latest automatic machines. They are made for lightly rammed boxes, to boxes used on the latest type of very high pressure moulding machines.

Illustration shows model style 'SLT'

Sterling

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STERLING FOUNDRY SPECIALTIES LTD., BEDFORD, ENGLAND.

593 Cogent

NO WASTE CASTINGS when you use SPERMOLIN core oils and binders

Photo by courtesy of Messrs. Macmillan Foundries Ltd, Watford

FOR quantity production of small cores or a special one-off job of exceptional size you can rely on Spermolin Core Oils and Binders for consistent accuracy. Short baking cycles and low sand core costs are but two more of the many advantages.

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REGISTERED TRADE MARK

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FOUMEC

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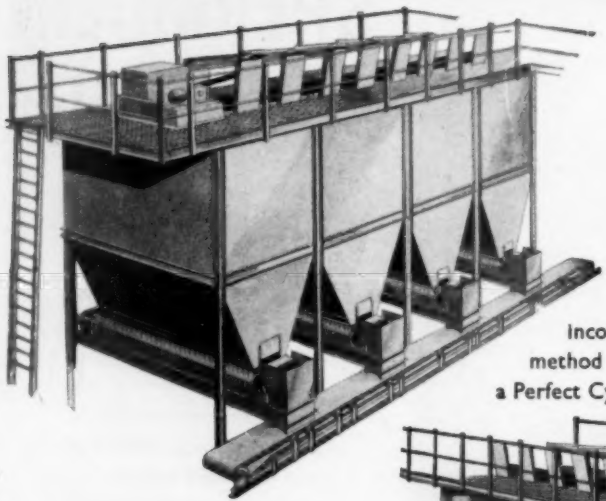
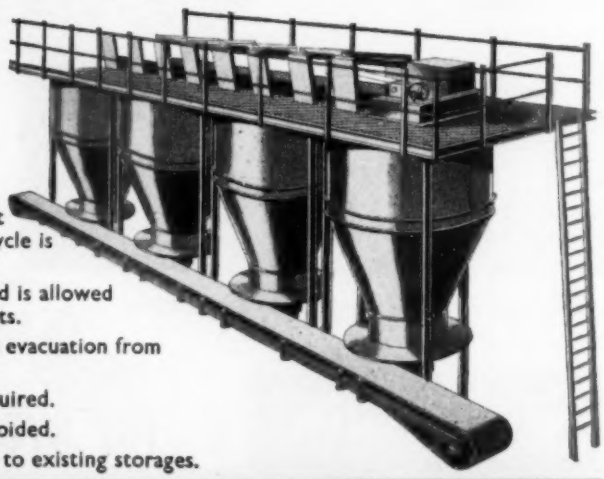


The Mechanised Plants we supply incorporate the ONLY 100 per cent. efficient method of ensuring the use of Returned Sand in a Perfect Cycle.



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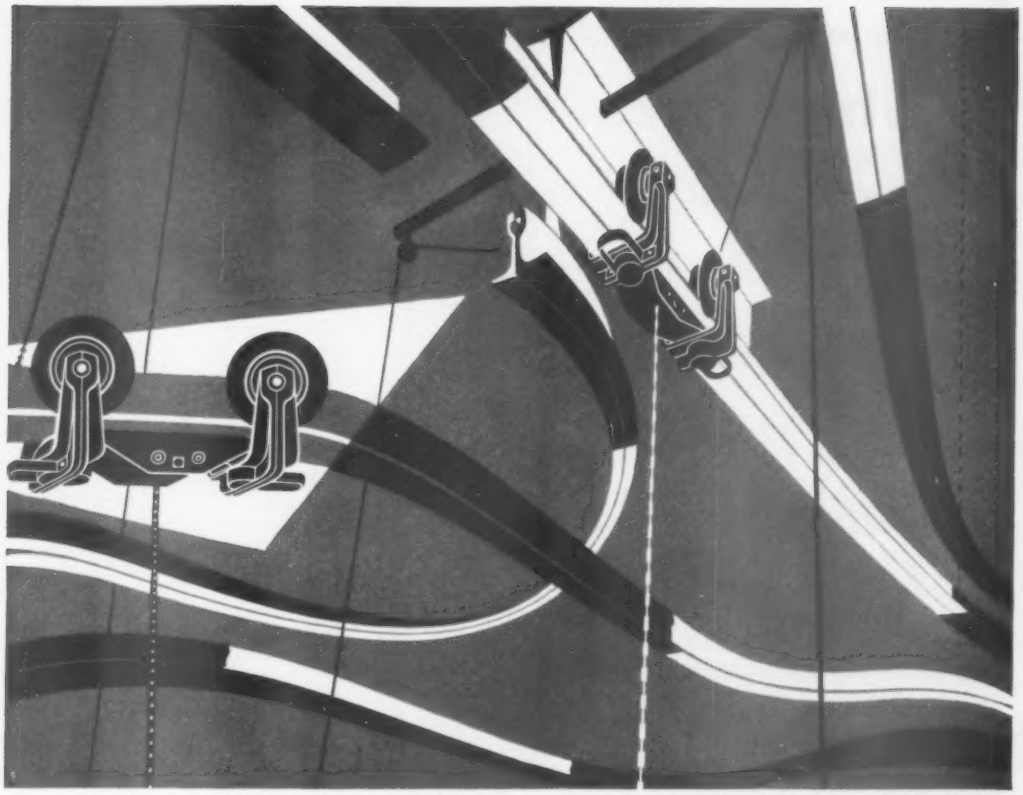
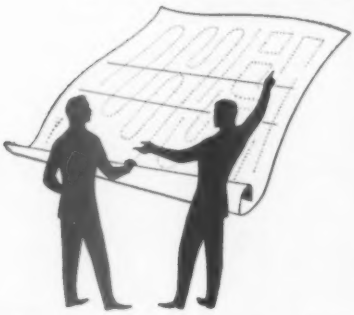
F.M.1



OVERHEAD is the open road



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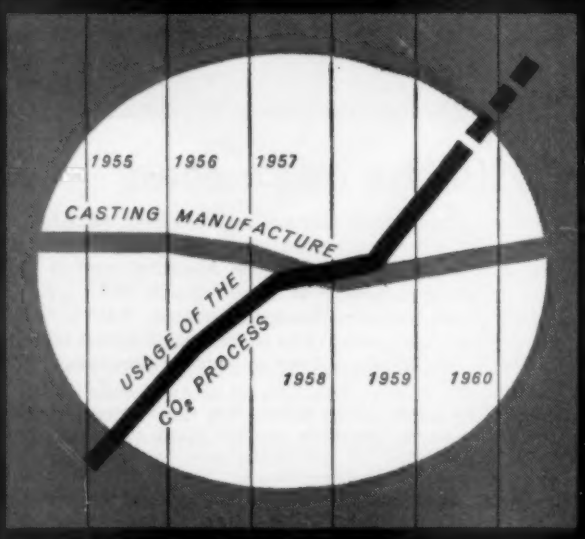
HARD AND FAST FACTS

why casting by the CO_2 process has increased sixfold in five years



For full details of the process that is revolutionising foundry practice everywhere, write to:

THE DISTILLERS COMPANY LIMITED · CHEMICAL DIVISION

Carbon Dioxide Dept. (CD) Devonshire House, Mayfair Place, Piccadilly, London, W.1.
Telephone: MAYfair 8867.

Sales Offices: Southern Area: Broadway House, The Broadway, Wimbledon SW19. LIBerty 4061. Northern Area: Queen's House, Queen Street, Manchester 2. Deansgate 8877.

The steep rise of the graph proves it—the number of castings produced by the CO_2/sodium silicate process has multiplied six times in five years. Here—hard and fast—are the facts why:

1

Simplicity—One unit sand is used throughout for all sizes of cores and moulds, cutting out complex sand mixing and testing. Sand bonding by CO_2 gassing is simpler, quicker, cleaner and surer and eliminates stove drying.

2

Economy—Savings in materials, fuel, equipment, maintenance and handling costs are substantial and the work content of cores and moulds greatly reduced.

3

Productivity—Casting yields have been doubled with the same floor space. Fewer moulding boxes are needed and turn-round is stepped up. Production becomes flexible, while less fumes and dust improve working conditions.

4

Quality Control—Without stoving, core and mould bonding is accurately controlled. Defective castings are drastically down, dimensional accuracy up and surface finish improved.

DCL

TA 4975

200 first class Shell Cores per hour

With the
ANSON 200
SHELL COREMAKING MACHINE

TWO COREBOX PRINCIPLE
MEANS VERSATILITY
100 CORES OF ONE KIND
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ALL OF MAXIMUM SIZE
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Ask also for details of the
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and the ANSON SHELL CLOSING PRESS

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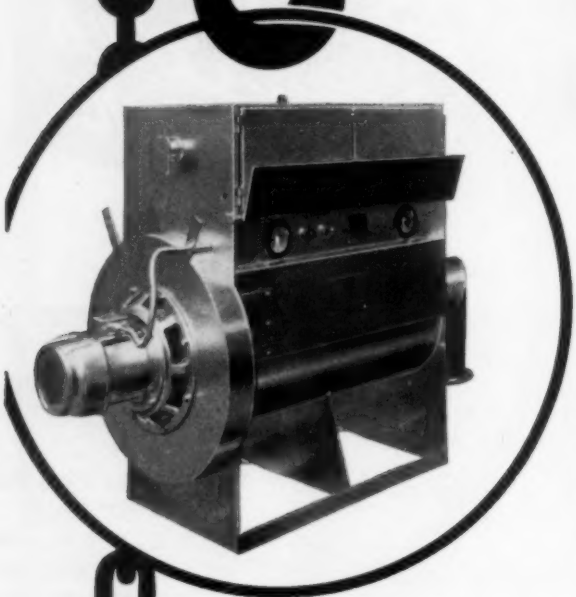
Phone : TRAfalgar 1141

BROWN BOVERI

PORTABLE ELECTRIC MOULD DRIERS



. . . designed for drying floor moulds or large box moulds for ferrous and non-ferrous metal castings. They operate by forcing hot air over the mould surface and through the sand giving quicker and more efficient drying than is normally achieved by other methods. Using air temperatures lower than hot gases, and less than one third the quantity of heat, they reduce drying times by half. Heating is uniform throughout the mould and despite rapid drying, surfaces remain free from cracks and cleaner castings are produced.

* Driers need no attention during operation.
* Power input is regulated automatically.
* Working conditions are improved by elimination of smoke and burning gases.

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Using the unique principle of *Selective Particle Acceleration, SPA collects harmful—and often profitable—dust with remarkable efficiency. Self-cleaning, boasting a high recovery rate, devoid of moving parts (and so requiring no maintenance!), SPA is available at a keenly competitive price.

And Steels produce other types of extraction equipment, too; cyclones (low pressure drop and high efficiency) and both manual and fully automatic fabric filters. All suitable for a variety of industrial applications.
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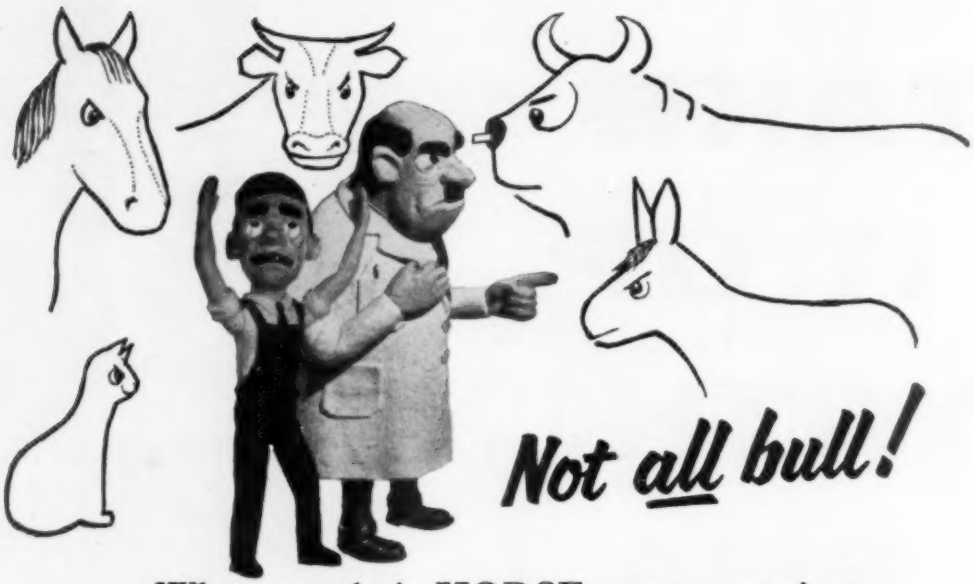

Whatever their HORSE power, engines purr like PUSSIES when their castings have been cored with Sternocore sand binders—they will go on doing this for DONKEY'S years. Sternocore products* can be equally trusted to give the same harmonious results till the COWS come home!

* *We won't bother you with the technical "gen" here, but just say the word and we will have a representative round with the milk in the morning.*

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- LOWER COST PER CORE
- SIMPLE OPERATION
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The SHALCO U180 fully automatic SHELL CORE BLOWER

Investing, blowing, rocking and curing cycles are controlled by adjustable timers, the operator merely presses a button and the U180 does the rest. Separate driers and ovens are eliminated.

The photographs appear by courtesy of GLOUCESTER FOUNDRY LIMITED

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DIVISION OF STONE-WALLWORK LIMITED
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The latest, largest, most powerful, ...

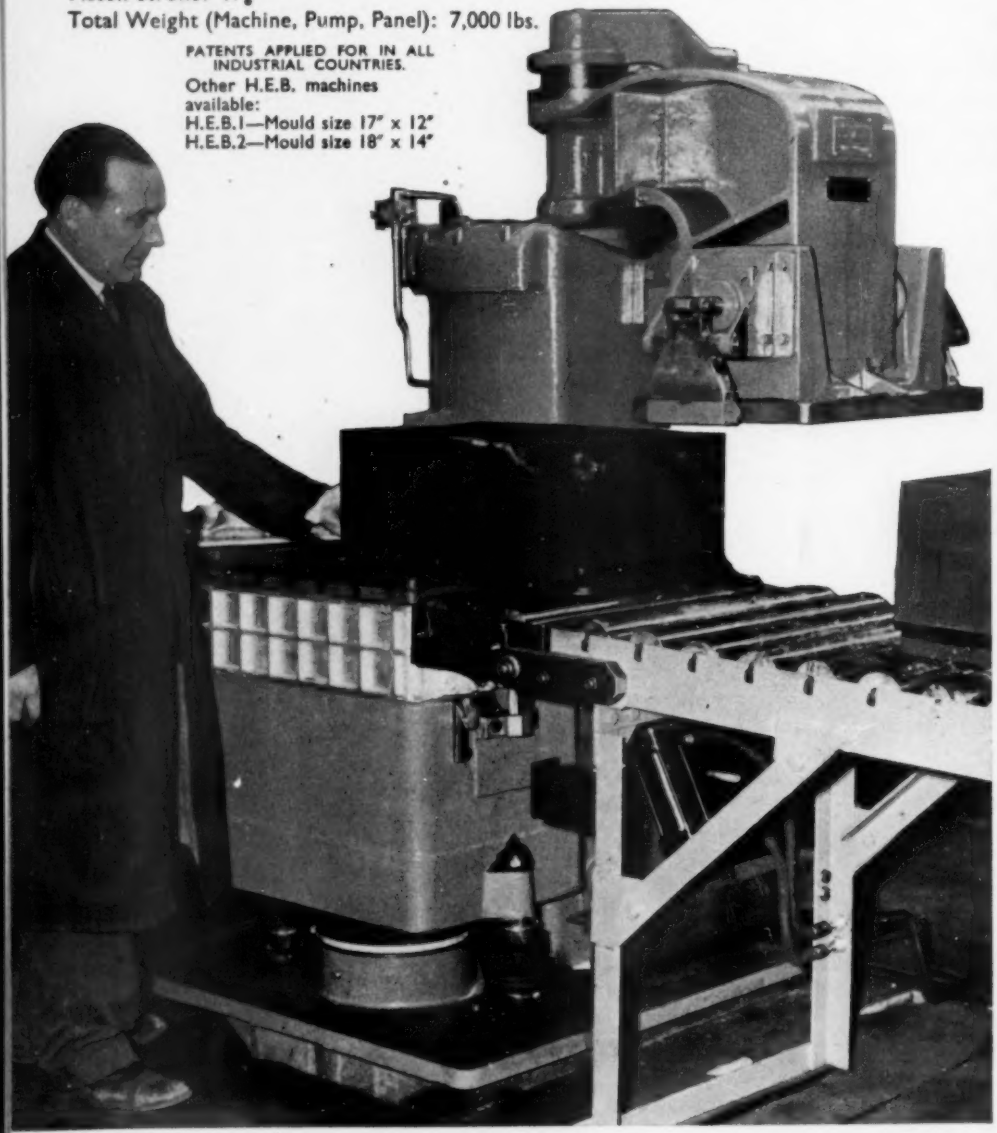
SPECIFICATION

Mould size (dimensions of sand block): 22" x 16".
Cope depth: 4". Drag depth: 4".
Squeeze pressure: 28,500 lbs.
Oil pressure: 1,250 p.s.i.
Piston Diameter: 5½".
Piston Stroke: 17⅛"
Total Weight (Machine, Pump, Panel): 7,000 lbs.

We invite your enquiries for our H.E.B. series and particularly for our brand new H.E.B.3 machine.

PATENTS APPLIED FOR IN ALL INDUSTRIAL COUNTRIES.

Other H.E.B. machines available:
H.E.B.1—Mould size 17" x 12"
H.E.B.2—Mould size 18" x 14"



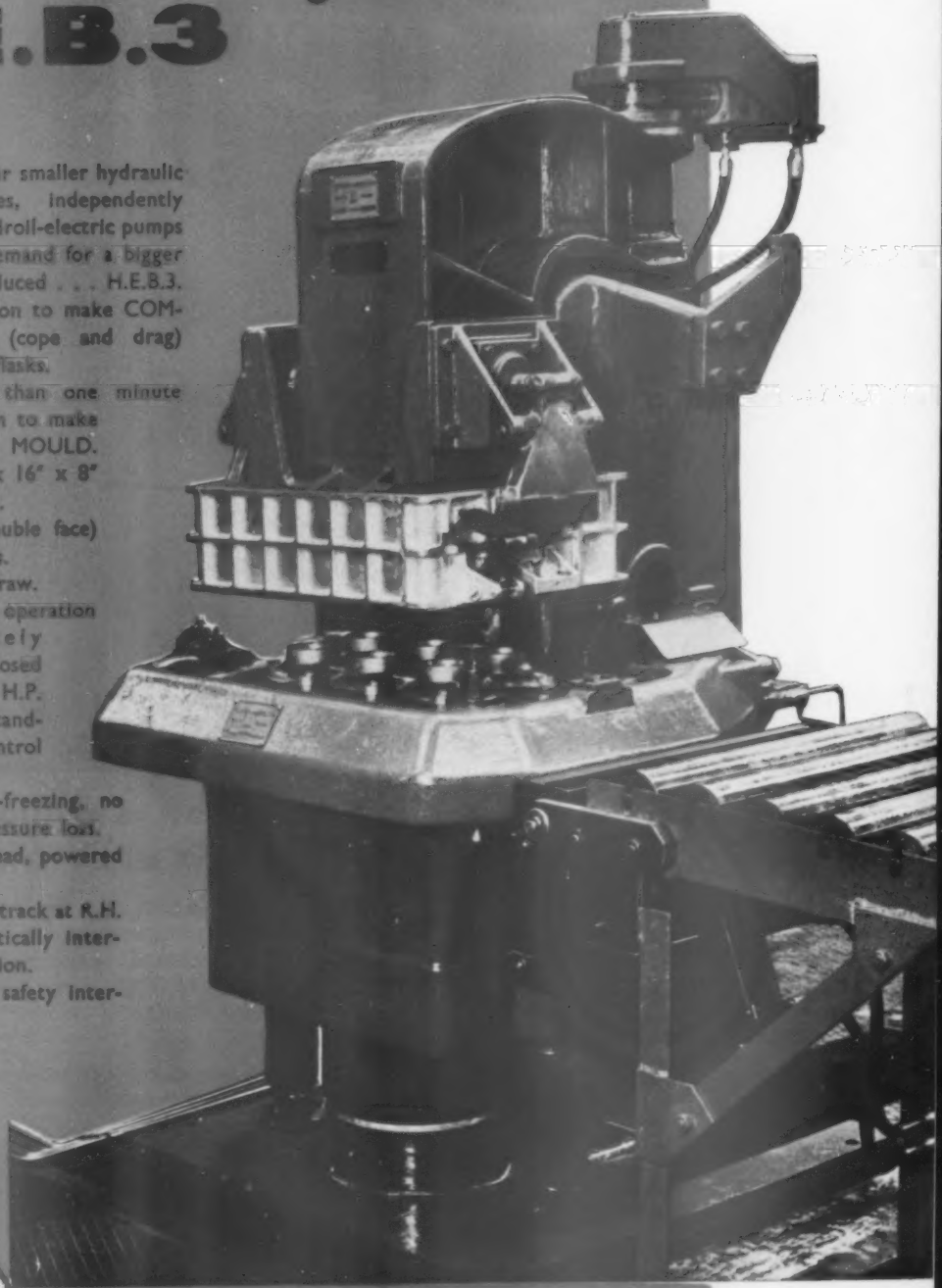
Foundry Equipment Ltd.

LINSLADE WORKS, LEIGHTON BUZZARD, BEDFORDSHIRE, ENGLAND

Telephone: Leighton Buzzard 2441 (5 lines) Telegrams: 'Equipment,' Leighton Buzzard, England

Boxless Moulding Machine

. H.E.B.3



The success of our smaller hydraulic Boxless Machines, independently powered with hydroil-electric pumps and the world demand for a bigger machine has produced . . . H.E.B.3.
One man operation to make COMPLETE MOULD (cope and drag) without boxes or flasks.
Production—less than one minute cycle for one man to make one COMPLETE MOULD.
Mould size: 22" x 16" x 8" (4" cope, 4" drag).
Pattern plate (double face) changed in seconds.
Adjustable slow draw.
All oil-hydraulic operation from separately mounted enclosed pump unit (7½ H.P. motor) and floor standing remote control panel.
Non-rusting, non-freezing, no pipe lines, no pressure loss.
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Roller strip-on to track at R.H. side with automatically interlocked lift-up section.
All movements "safety interlocked".

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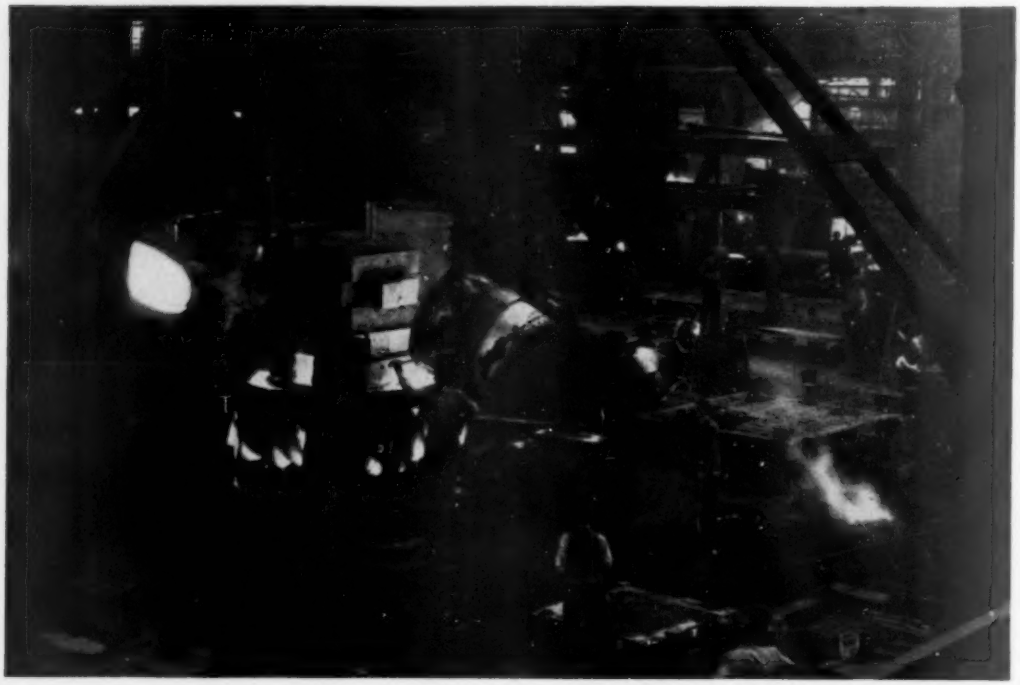
AGENTS IN ALL INDUSTRIAL COUNTRIES

FOUNDRY MECHANISATION



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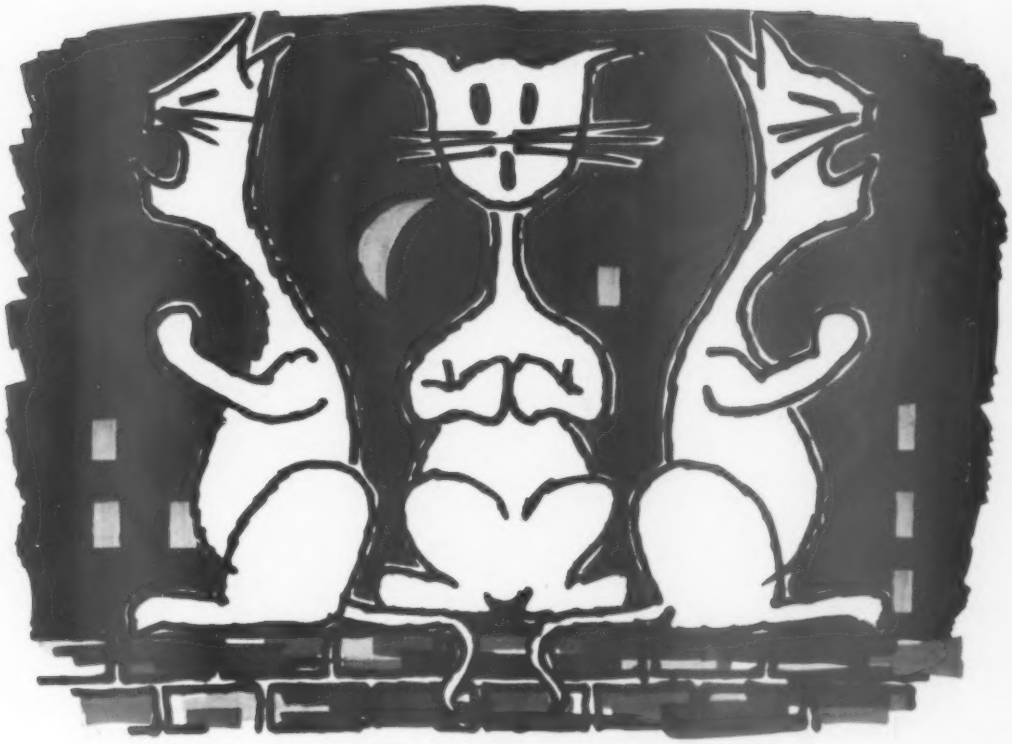
TGA MH28

A tale of seven cats...



CATASET

Here's a fine set of Cats!—a range of Air Setting Resin Binders specially bred by Catalin for use for cores and for mould facings backed up with regular moulding sand. With simplified and improved accelerating systems they give a better, cleaner finish and a big reduction in time and fettling. Foundry managers like to have these Cats around—they save them so much money. Why not set them to work for you

SIX MORE CATS FROM CATALIN

CATALAC Flame and Air Set Sprays give a good casting finish and a clean strip. Foundry managers find that this kind of Cat keeps fettling down to a minimum.

CATACORE the specialised quick-baking binder. Here's a Cat that makes a core that makes foundry managers purr with satisfaction because it gives them faster, smoother, cheaper cores.

CATAMOLD is a range of powdered Shell-Moulding Resins. All the Cats in this family produce excellent shell mouldings, without 'peel-back'.

CATABOX This Cat will give you a choice of resins for the Hot Box process. There are Furane type or single stage phenolics. Catabox specialises in speed and quality.

CATAWASH Here's a whole family of Core and Mould Washes, bases and paints. Like all of the Catalin Cats they'll keep your castings really clean.

CATACOTE Better casting is this Cat's business—a cool Cat for the cold pre-coating of sand—for better shells at far less cost than conventional resins.

Catalin's specialised knowledge and years of research into foundry resins and resin conversion can help you in your foundry. Catalin will even breed new Cats to overcome your special problem. Ask a Catalin man to call and give you a Cat Show in your foundry.

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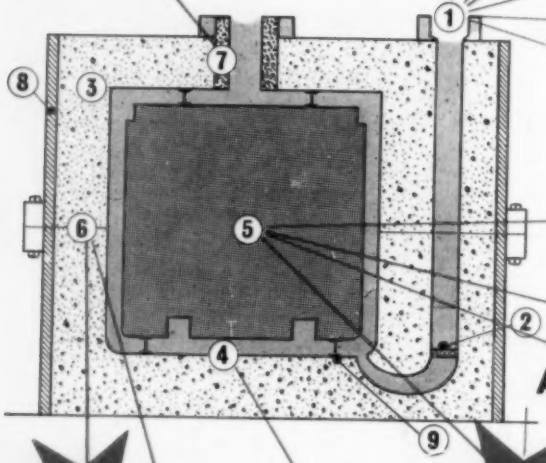

Key to Sectional Drawing of Mould

		Send for booklet No.
1	Metallurgical Control use of Fluxes	3
2	Clean Metal by using Ceramic Strainer Cores and Discs.	4
3	Coal Dust additional to Facing and Backing Sand	1
4	Silverskin Blackings, Plumbago and Mould Dressings.	1
5	Cores using Crulin and Crudol Core Binders (Oil Bonded, Air Setting Cereal or CO.2 Binders).	2
6	Moulds Parted with Beecro Silica Free Parting Powder or Beecrol Parting Liquid.	1
7	Casting Feeding with Alsica Exothermic Feeder Heads.	4
8	Moulding Boxes supplied by B.F.U. Chaplets, Studs, etc.	5

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Fourteenth century carving of a sow and litter in Worcester Cathedral. Photograph by Ruth Meyler & F. C Sillar

50 MILLION PIGS GO TO MARKET!

In the early days of the industrial revolution manufacturers frequently looked for familiar and easily recognisable descriptions of their products. To the countryman transplanted into industrial surroundings nothing was more familiar than a pig; a fact which is emphasised by carvings in scores of old churches depicting pigs suckling their litter, rooting for acorns and playing the bagpipes. (Apparently this last pastime was forsworn by pigs many years ago because of unpleasant associations between bagpipes and pigs bladders.) Consequently, when iron from Blast Furnaces was directed into long troughs and from there into short and narrow troughs placed at right angles, a resemblance to sows suckling their appendaged litter led to the description of 'pig iron'.

This series of advertisements illustrates some of the 'ecclesiastical' pigs and emphasises the 50,000,000 'special' pigs which Warner and Company have supplied to Iron Foundries producing High Duty Castings.

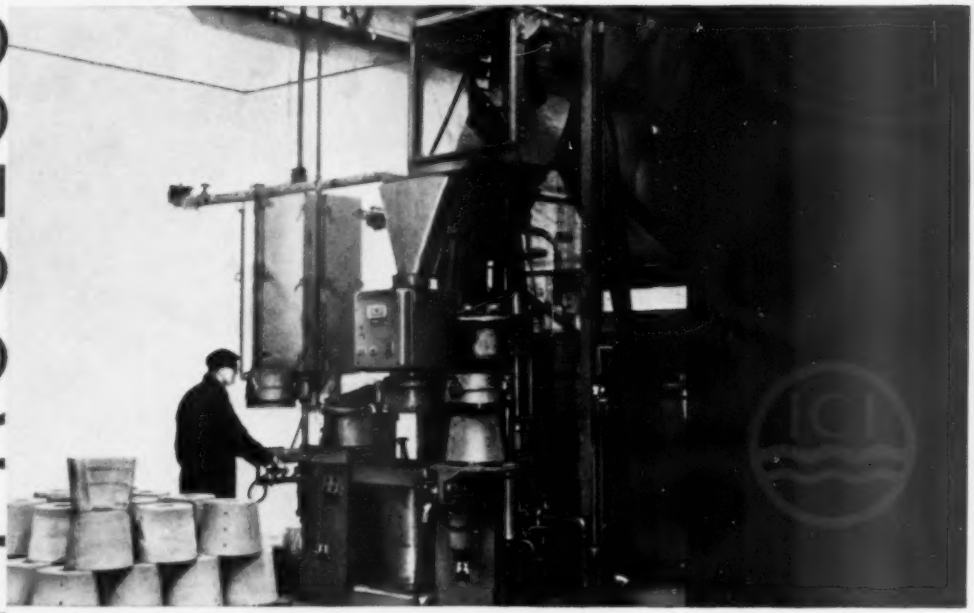
WARNER WARNER WARNER

"Pioneers of Refined Pigiron"

KA

WARNER & CO. LTD., MIDDLESBROUGH

CO_2 SILICATE PROCESS



DISTINGTON STREAMLINE PRODUCTION WITH I.C.I. PRODUCTS AND THE CO_2/SILICATE PROCESS

Distington Engineering Co. Ltd. are one of Britain's largest foundries—and one of the most go-ahead. They use I.C.I. products and the CO_2/silicate process for the production of runner and feeder bushes. The dry sand method of producing these bushes was cumbersome and time-consuming, and as bushes made in silicate-bonded sand gave good results, Distington adopted the process and set out to streamline production.

Using a Hansberg core-shooting machine, modified to their special requirements, Distington have now mechanised the manufacture of the bushes. Production is automatically controlled from the time the core boxes are moved on to the machine until the completed bush is lifted clear. Accurate regulation of the gassing operation ensures that wastage is reduced to the minimum, and the mechanical handling of the bushes means that a high rate of production can be maintained by the operator. The hardness of silicate-bonded bushes allows them to be stacked on pallets, and so their distribution throughout the foundry is a simple matter.

To Distington, I.C.I. products and the CO_2/silicate process mean speedy, regular production, and reduced labour and material costs. Distington installed I.C.I.'s 5-ton CO_2 tank in order to buy CO_2 the cheapest way—as liquid in bulk. For maximum convenience and economy they have also installed two tanks for the bulk storage of I.C.I. sodium silicate, and they use I.C.I. isopropanol to prepare mould and core dressings. In short, Distington have found that I.C.I. products and the CO_2/silicate process save them time and money.

IMPERIAL CHEMICAL INDUSTRIES LTD., LONDON, S.W.1.

I.C.I. PRODUCTS AND THE CO_2/SILICATE PROCESS

The Distington Engineering Co. Ltd. and many other modern foundries use the CO_2/silicate process because it eliminates stoving, cuts fuel costs, cuts handling charges, saves time, and increases output. I.C.I. supplies for the CO_2/silicate process:

CARBON DIOXIDE
'Drikold' solid CO_2 used in the 'Drikold' liquefier—a convenient source of CO_2 for smaller foundries.
Liquid CO_2 in bulk and I.C.I.'s 5-ton storage tank—recommended for the larger foundry.

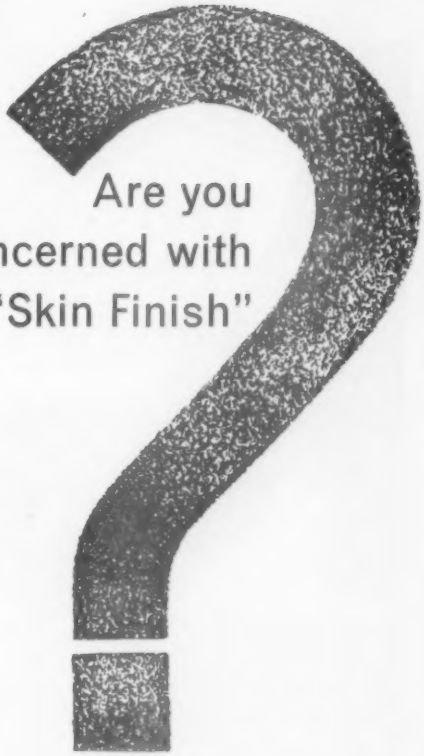
SODIUM SILICATE
grades C.112 and C.125—supplied in 10- or 45-gallon drums, and in road or rail tank vehicles.

ISOPROPANOL
for the preparation of ignitable mould or core dressings. Refined isopropanol or 'Imsol' A (isopropanol/water azeotrope)—supplied in 45-gallon drums or in road or rail tank vehicles.

TECHNICAL SERVICE
The skill and experience of I.C.I.'s Technical Service staff are available for the assistance of customers both in the selection of products and the operation of the CO_2/Silicate process. For a visit by a technical service representative, or for further information, get in touch with:

IMPERIAL CHEMICAL INDUSTRIES LTD., LONDON, S.W.1. DK 349

CO_2 SILICATE PROCESS



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ZIRCON SAND AND FLOUR

for cleaner castings.

ASSOCIATED LEAD
Manufacturers Limited
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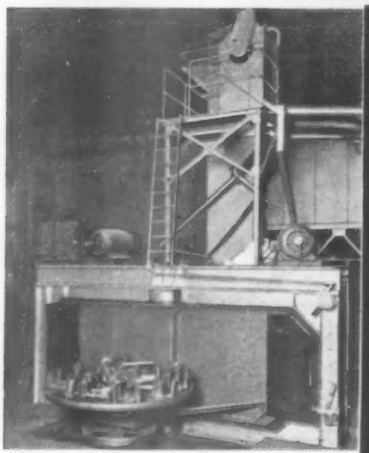

Dual Swing Table Wheelabrator Plant using Wheelabrator Steel Shot

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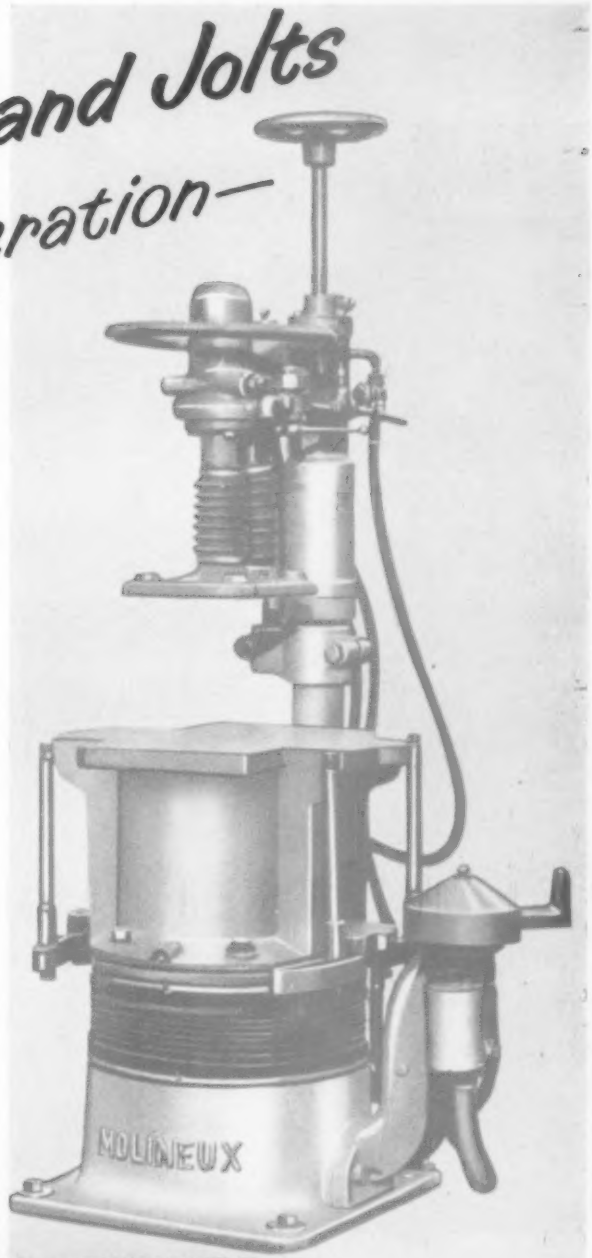

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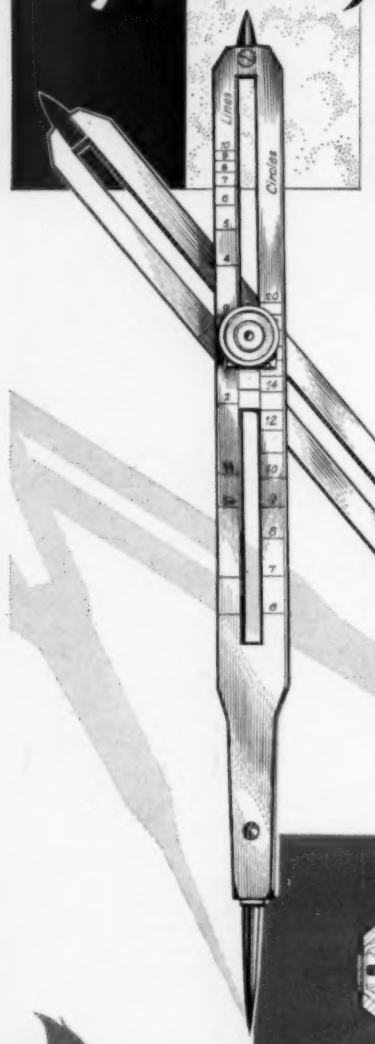

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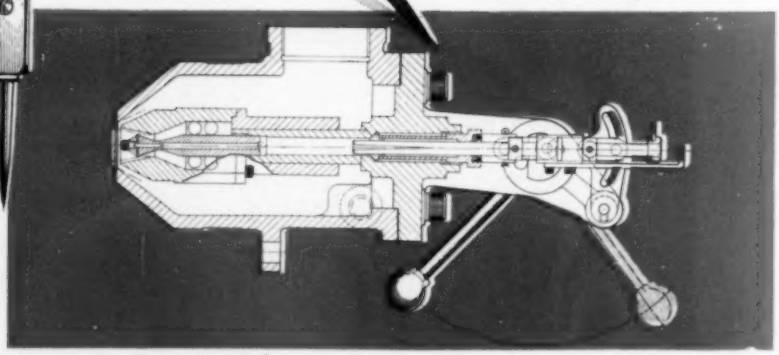

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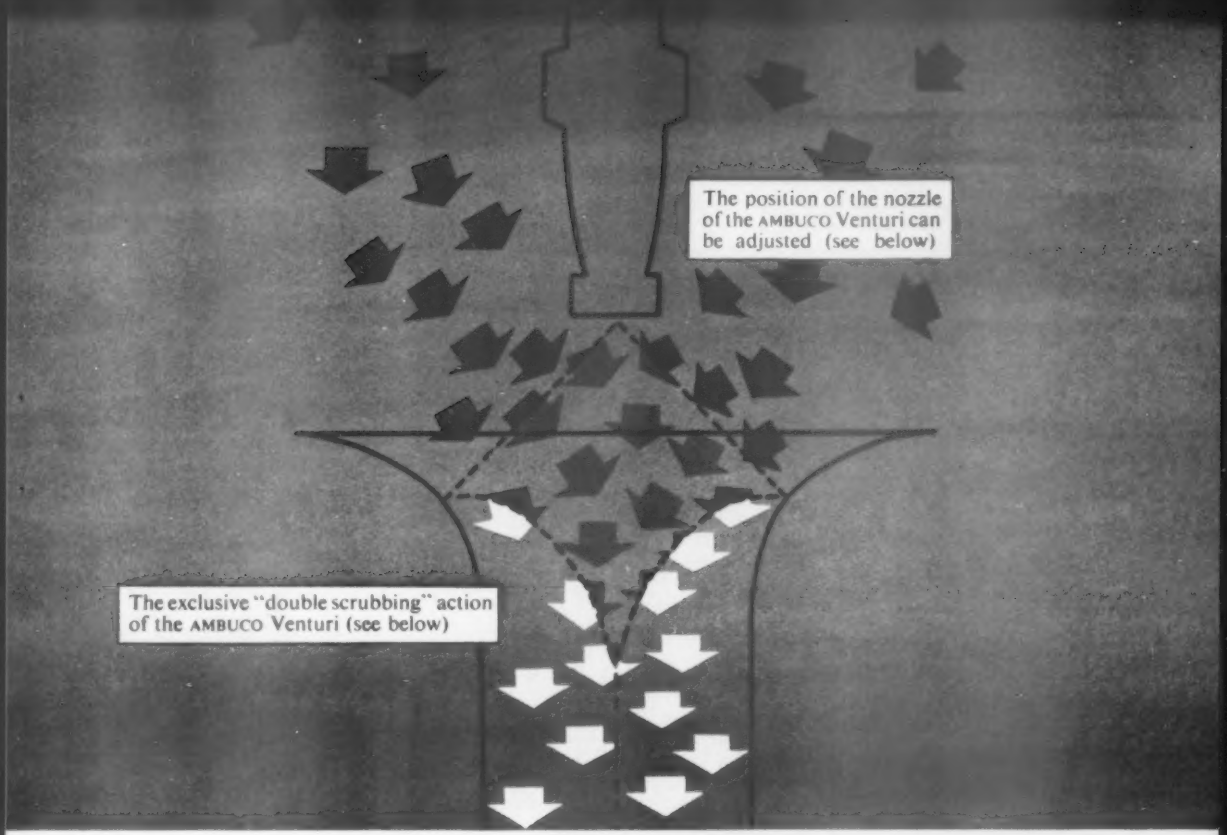
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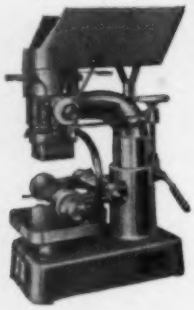

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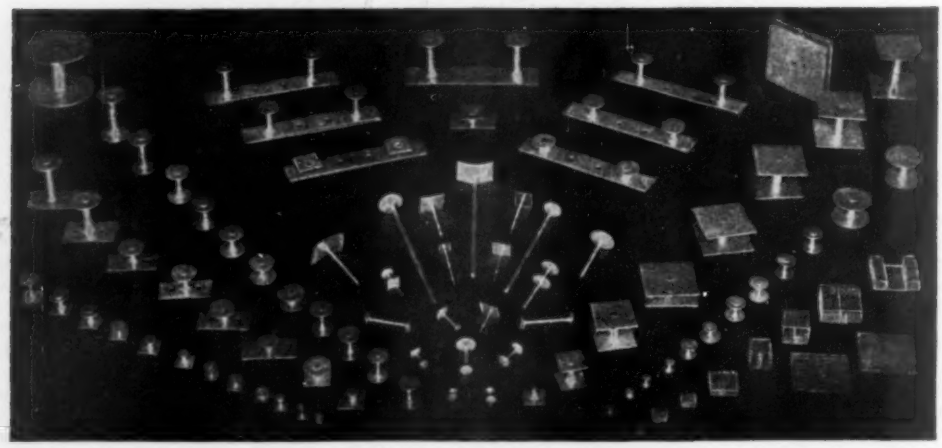

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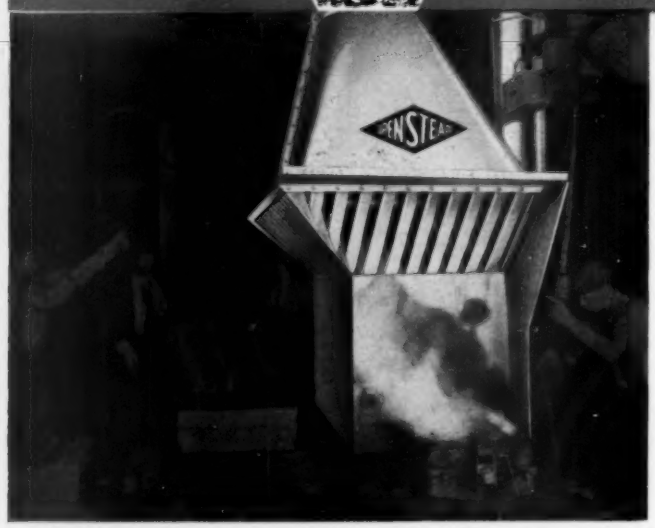

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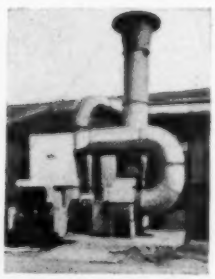

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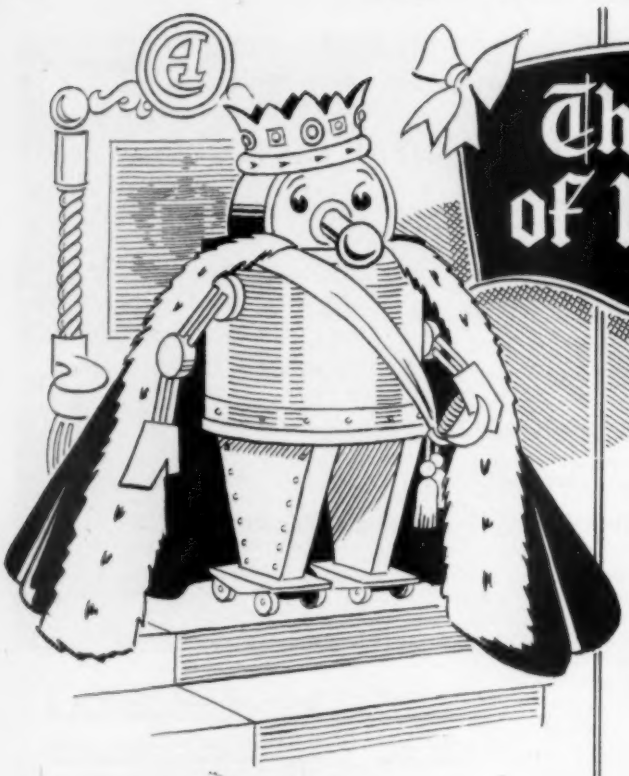

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FOUNDRY
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Registers of Research

The Production Engineering Research Association has been asked by an international body covering this particular field to prepare a register of work being undertaken in production engineering throughout the world. The objective is to avoid duplication of effort and by multi-language translation the better to disseminate research results mondially. This activity has much to commend it, except that where firms are supporting a research association, they do expect to receive some benefits, if not quite to themselves, then for the home industry.

So far as the foundry industry of the world is concerned, a similar action is not called for, as the conditions are such that information gained through research is readily available on a world basis, though there is sometimes a short delay before open publication. Moreover, there is reasonably close personal contact between the scientific and technological staffs of both research associations and the foundry industry at international conferences, their various commissions, international standards organizations and the technical Press, to ensure that there is reliable information always available as to work in progress.

To our mind, it is to be regretted that the Americans have not so far found it either necessary or desirable to initiate foundry co-operative research on a national basis, though they are—we are aware—well served by institutes undertaking sponsored foundry research. Moreover, some American Government departments are quite active in foundry research and their results seem to be freely available to the public. Probably the sum total of American research is as large, if not larger, than that of most countries. Throughout the world, a vast amount of foundry research is done by the suppliers of raw materials and equipment to the foundry and for this, founders are undoubtedly grateful. Yet the business of making commercial castings is sufficiently important for the industry to sponsor and pay for its own investigations. Thus, a register of current foundry research activities—whilst by no means necessary—would at least be interesting and make possible a rapid appraisal of the situation for any given topic.

Correspondence

To the Editor of the FOUNDRY TRADE JOURNAL

A FOUNDRY ENGINEERS' GROUP?

SIR,—I thank Mr. R. K. Kapoor for his support (JOURNAL, August 31, page 250) regarding the proposed formation of an "engineers' group." The first objective of such a body would be to co-ordinate the activities of existing bodies concerned with research into and development of foundry plant and machinery, for at times I am convinced their efforts are dissipated when, with joint effort, the industry's problems would be solved more easily. The pattern of this group should be on a national basis and the activities I am sure would have the blessing of the foundry industry in general. I invite the organizations mentioned in this correspondence to make comments in due time and meanwhile perhaps Mr. Kapoor would give further observations for its seems there is at least one other enthusiastic foundry engineer. Yours etc.—"ENTHUSIASTIC ENGINEER (FOUNDRY)."

There is ample precedence for the formation of an engineers' group within the foundry industry, as several learned institutions have similar working arrangements. For example, there is an Engineers' Group within the Iron and Steel Institute which has been operating with signal success for several years. In a number of industries it has been realized that a gap exists between technologists and those applying technology in machine design, works layout and production techniques. The bridging of this gap on an official plane, however, is not a simple matter, because of the many interests involved. Nevertheless, it seems that our correspondent has at least a working basis in visualizing action through the Institute of British Foundrymen. In a number of directions, this sort of co-operation already exists as a result of joint membership and representation on councils and committees of the various research, manufacturers' and technical associations of the foundry industry.—EDITOR.

Revised BS for Cast-iron Baths

In response to a request from those responsible for the care of elderly people and invalids, who often have difficulty in getting in and out of the baths, the technical committee of the British Standards Institution have added, in their revised edition of BS 1189 for cast-iron baths, a rectangular, shallow bath to the existing range of patterns. It is hoped that in future this type of bath will become a standard fixture in old people's residential and nursing homes, and in dwellings built especially for the elderly.

The new pattern is as shallow as possible, while allowing for the normal height for fixing a trap under the bath above floor level. Where it is possible to sink the trap below floor level, the rim of the bath can then be brought to only 16 in. above floor level. In this type of bath, it is also possible to have the tapholes in a position allowing cornerwise fixing near the front of the bath—an added convenience for the elderly. When ordered, raised handgrips may also be fitted.

As there is now a growing tendency not to fit overflows to baths, except where by-laws insist on this, the provision of holes for overflow fittings has been made optional. Among other changes in the revised standard is the inclusion of advice on filling and cleaning baths. Copies of the standard may be obtained from the sales branch of the Institution, 2, Park Street, London, W.1 (price 6s., plus postage).

Baker Perkins' New London Office

An appeal to the Government for a preferential bank rate for the export trade on long-term credit sales was made by Mr. Harold Crowther, chairman of Baker Perkins (Exports), Limited, on the occasion of the official opening of the company's new offices in Stanhope Gate, London, W.1. He said that the Government was penalizing the home market and this could have serious repercussions in the export market if research and development had to lag behind due to enforced economies which might have to be introduced to counter some of the recent measures taken by the Government, particularly where credit and high interest rates are concerned.

The Rt. Hon. F. J. Erroll, Minister of State, Board of Trade, who performed the opening ceremony, said in reply to Mr. Crowther that he did not think it was the right occasion to indulge in a debate on Government policy. He would, however, consider carefully Mr. Crowther's remarks. He was amazed, when told by different people of the difficulties that were hampering British exports, that there were any exports at all. Nevertheless, the year's rate of £300,000,000 a month was quite an achievement. He understood that last year had been a record one for Baker Perkins in the export market and he hoped the company would not be satisfied with that but would make this year an even better one.

The new offices have been named Westwood House after the parent concern's head office and works in Peterborough, Northants. As well as housing the export department, they will also be used by home sales managers, Baker Perkins Jaxons, Limited, James Halley & Sons, Limited, and Steele & Cowlishaw, Limited.

World Register of Research Task for PERA

Task of establishing a world register on production engineering research has been given to the Production Engineering Research Association, at Melton Mowbray (Leics). It will have the financial support of OEEC for two years. The register will help research workers and production engineers to keep fully informed about investigations carried out in research organizations, industrial firms, universities, and colleges throughout the world.

The world register will cover all production research carried out in the years 1959 to 1962, and will summarize plans for research for the following three years. Main subjects to be covered are: Automation, machine tools, materials handling, finishing processes, metal forming, assembly, inspection and measurement, metal cutting, machine ability, and formability of materials.

IVE Banquet: The annual banquet of the Institute of Vitreous Enamellers is to be held on Friday, September 29, at the City Livery Club, Sion College, Victoria Embankment, London, E.C.4, at 7.0 for 7.30 p.m., following the annual general meeting and Foundation Lecture earlier that afternoon. Tickets (price £4 4s. 0d., including wines) are still available and those wishing to attend (members and male guests) should write immediately to the secretary, Mr. J. D. Gardom, Ripley, near Derby.

Hollow Castings and Vessels . . .

. . . a suggested Novel Method of Production

*By R. H. T. Dixon, A.I.M., A.C.T.(Birm.), and J. E. Whittle**

The successful extension of the principles of centrifugal casting to two-plane spinning in order to produce hollow spherical shapes would be a useful step in founding, with interesting possibilities. Although it is not the practice of the JOURNAL to publish details of hypothetical processes, it is felt that the step is justified in this instance as it may lead to a more extensive investigation into the practical application of the methods outlined. It is emphasized that the metal behaviour described and depicted here is that suggested as most probable by the Authors; it does not relate to observed phenomena, as experiments did not involve the use of liquid metals.

It has long been appreciated by metallurgists that the shape most difficult to cast completely sound in a metal or alloy is a sphere. Unless the metal ingate is of very-large size, and well insulated thermally, it will not allow feeding of sufficient liquid metal to the mould cavity. With the aim of overcoming this problem many techniques have been devised, some of which have been partially successful: the methods tried include the use of composite moulds of various types (e.g., part chill, part heat-insulating refractory). However, most of these methods suffer from the disadvantage that the micro-structure of the sphere produced is non-uniform, and often very large feeder heads are required, resulting in low yield.

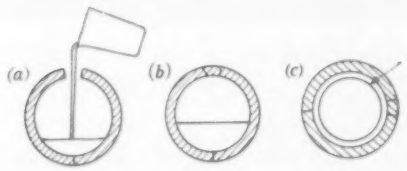


FIG. 1.—*Two-plane spinning cycle; (a) liquid metal poured into the static mould; (b) mould closed; (c) mould rotated symmetrically about two planes at 90 deg. to each other. Arrow indicates the solidified metal sphere.*

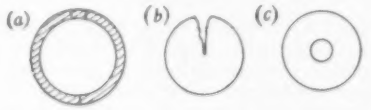


FIG. 2.—*Comparison of the shrinkage cavities produced by static and rotary methods; (a) closed mould filled with molten metal; (b) solidification in a static mould; (c) condition of the metal solidified in a two-plane rotated mould.*

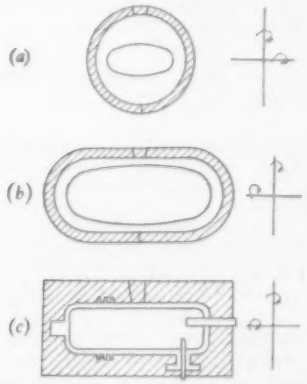


FIG. 3.—*Effect of variations in rotary motion and mould shape; (a) horizontal speed of revolution twice that of the vertical; (b) horizontal speed three times that of the vertical; (c) relative speed as for (b) but for a more-complex casting.*

Two-axial Rotation

For many purposes (e.g., for grinding- and crushing-balls) it is very desirable to have a completely-sound ball of uniform structure and properties, in order to ensure satisfactory performance in service. It is obviously not a simple matter to meet this requirement, but the Authors consider that, by applying two-axial rotation to the mould, it would be possible to produce a ball of uniform structure and properties, with a central spherical shrinkage cavity. The resulting yield would be 100 per cent. Such an arrangement is indicated diagrammatically in Figs. 1 and 2. Fig. 1 shows the mould cavity being filled with molten metal or alloy, and the effect of symmetrical rotation of the mould about two axes at right angles (axes intersecting at the

* When this research was carried out, both the Authors were associated with the International Nickel Company (Mond), Limited, Birmingham. Mr. Dixon is now with Sheepbridge Engineering, Limited.

Hollow Castings and Vessels

centre of the mould cavity) throughout the period of solidification. In the experiment illustrated in Fig. 1 the mould was only one-third filled with metal. Fig. 2 indicates what happens when the mould is completely filled prior to bi-axial rotation. If the mould remains static the casting produces a typical vee-shaped outcropping shrinkage-

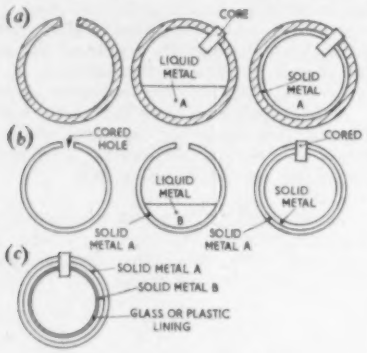


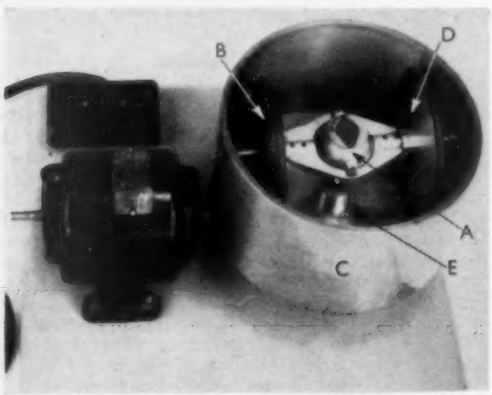
FIG. 4.—*Use of the rotated-mould process to produce internally-clad vessels.*

cavity, whereas the casting produced in the bi-axially-rotated mould has only a small central smooth-walled spherical shrinkage-cavity.

Complex Moulds

The above examples obviously represent only very simple cases, but development of the essential theme can result in a variety of types of hollow

FIG. 5.—*Model rotary-casting apparatus. Key:—A—spherical mould rotated by fixed pulley B about a horizontal axis. Drum C also rotates and provides motion about a vertical axis. Pulley D is an idler and pulley E fixed to the base plate acts as a track for D and B.*



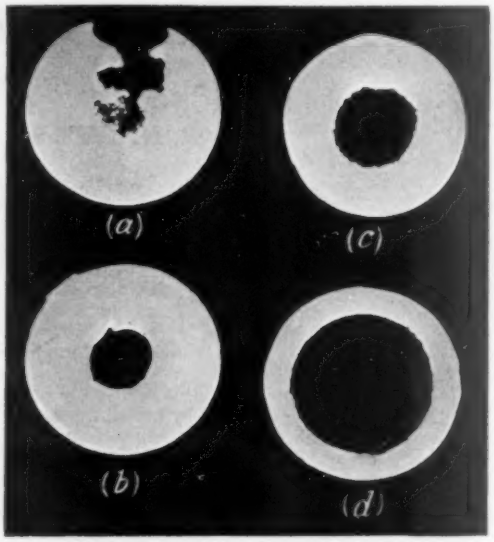


FIG. 6.—*Stearin-wax ball castings produced in—(a) static mould—(b), (c), and (d) rotated moulds with various amounts of wax in the mould cavity.*

casting. Fig. 3 indicates a few typical simple variations; in 3(*a*) the two components of the bi-axial rotation are not equal, and are applied to a spherical mould; 3(*b*) illustrates the similar rotation of a cylindrical mould, and 3(*c*) shows this type of rotation being applied to a complex mould, which includes cooling fins, cores and flanges. Many more variations of this type are obviously possible, to produce a wide range of shapes; control of the rotating motion will give control of the shape of the central cavity, and in all cases a smooth interior surface can be obtained, together with virtually 100 per cent. yield.

Cladding

A further refinement of the same technique may be used to produce a lined or an internally-clad vessel; such an arrangement is shown in Fig. 4. Sequence (*a*) indicates the production of a hollow shell in metal or alloy A. This shell is then used as the mould of a sequence (*b*), using another type of metal or alloy, with the result that hollow vessel (*a*) becomes lined with metal (*b*). (Cores can be used to ensure that a hole remains for pouring-in the second metal.) This internal-coating can obviously be repeated and, provided that metals and alloys of suitable physical properties are chosen, many different types of vessel may be produced. The innermost coating could, indeed, be of a suitable glass or even of a plastic material, which would ensure the excellent corrosion-resistance of the non-metallic material, coupled with the high strength of the metal backing: such a composite would be advantageous, for example, in applications

where highly corrosion-resistant metals or alloys are generally considered to be unsuitable (e.g., for contact with strong hydrofluoric acid).

Casting Machine

In order to demonstrate this type of process experimentally, a model casting machine was produced (Fig. 5). This was designed to produce symmetrical rotation of a spherical mould about two planes at right angles (axes of rotation intersect at the centre of the mould cavity). Experimental stearin-wax castings produced with this model, (shown in Fig. 6) clearly illustrate the type of result which could be achieved. A study of the model will indicate that the principle is not difficult to apply, and since the speeds of rotation required would probably not be high, the mechanics of the mould-rotation are more practicable than might at first be apparent.

The technique described thus has many attractions, and could be used to produce a wide variety of hollow vessels, lined or unlined. The central cavity can be closely controlled over a wide range of selected limits, and it could reasonably be expected that the application of the process to a ball mould would result in the production of a ball showing superior strength. Such a technique could be applied to the production of large (12-in. dia.) thick-walled hollow spheres, for example, abrasion-resistant alloy white cast iron Ni-hard grinding balls such as are used in some types of crushing mill. Many other effects usually associated with centrifugal casting processes also result from the use of the process described; among these are metallurgical structural modifications (e.g., grain-refinement). In cases where there is no outlet from the central mould cavity to the outer atmosphere some degassing of the metal would occur, and the surface of the inner cavity would most probably be bright and not oxidized.

Acknowledgment

The Authors wish to acknowledge their indebtedness to the International Nickel Company (Mond), Limited, for permission to publish this paper.

Book Reviews

Rare Metals Handbook (Second Edition), edited by Clifford A. Hampel. Published by Chapman and Hall, 37 Essex Street, London, W.C.2; price 162s. post free.

Developments in nuclear and space work have promoted some of the less-common metals from being museum specimens to becoming materials of industrial importance. Extraction metallurgy took on a new lease of life as bulk production and purification methods of these metals had to be perfected. By 1954 there was a place for the "Rare Metals Handbook" and this second edition covering six more elements has appeared seven years later.

A total of 55 metals is now dealt with in individual chapters prepared by 44 various authors. Each chapter describes the occurrence, manufacture, properties and costs of its metal, and in many cases of its alloys too. There is naturally a variation of quality from chapter to chapter, depending upon the interests of its author and the completeness of his card index. Thus the "ductility" of cadmium is listed in a table of its physical constants as "considerable" (based on a reference dated 1818) whilst its hardness is given simply as 2.0 on Mohs scratching scale as reported in the year 1900. The chapter on manganese does not include some hardness information published in Britain in 1956, although the new edition claims to be up to date. On the other hand there are nearly 60 pages about the artificial element plutonium and its alloys, including 13 phase diagrams, many micrographs and 224 references, whilst information on the rare-earth metals is also welcome.

The modern foundryman will be interested in the accounts given of preparing many of the metals by arc melting, drip melting, electron-beam fusion and sintering, whilst many unusual crucible and mould materials are mentioned. Sometimes the foundry operations have to be carried out in "glove boxes." One learns from the book that the price of plutonium is about 25 times that of gold so here one is moving in a very exotic environment. On the other hand, cesium and rubidium are listed as being about one fifth of the cost of gold and they are being used, after vaporisation, in ion propulsion engines which are being developed for space vehicles.

This book is very well produced and the checking of the printing of such a wealth of data must have been a formidable task. It is probable that before long a further edition will be needed.

HUGH O'NEILL

Engineer Apprentice Manual: Published by Trade & Technical Press, Limited, 55a, Stonecot Hill, Sutton, Surrey; price £2 2s. 0d.

This latest 400-page addition to the many sources of information now available to the engineering apprentice, provides in a very convenient way, a wealth of practical detail. Most books of this nature usually prove to be rather too technical and often deter many young students from delving into the various aspects of general engineering, whereas this book has been written in terms associated with the shop-floor.

The 20 or more sections, which are illustrated with simple, easy-to-understand diagrams and sketches supplemented by photographs, cover practically the whole field of general-engineering techniques, from the drawing office right through the various workshop processes and follow up with useful articles on design, training materials, British Standards and engineering units, etc., all of which should prove informative to the aspiring engineer. A striking feature of these articles is the manner in which they have been presented, and although somewhat concise, they do cover all the basic principles concerning the subject under review, and give the reader an excellent overall understanding of the various manufacturing techniques.

For example, in the article on foundry practice in addition to details of materials, tools, how to use them, why they are used and various methods of moulding, patterns and cores, aspects of safety are also included —a very important point in any workshop.

Finally, whilst the book cannot be regarded as a textbook it is most certainly worthy of a place at one's elbow both during apprenticeship and as a reference book in later years.

H. C. BUTLER.

VISCO ENGINEERING COMPANY, LIMITED, incorporated in 1921, changed its name on August 10 to Visco, Limited.

Joint Standing Committees

. . . Health and Safety in Non-Ferrous, Iron, and Steel Foundries

The Minister of Labour, Mr. John Hare, has used his powers under the Factories Act, 1959, to re-appoint the Joint Standing Committee on Health, Safety, and Welfare in Non-Ferrous Foundries. The function of the Committee, which has been appointed for three years, is to advise the Minister on matters affecting the health, safety and welfare of persons employed in non-ferrous foundries.

The Committee was re-appointed after consultation with the various employers' organizations and trades unions. It replaces and will continue the work of the Joint Standing Committee on Conditions in Non-Ferrous Foundries which was set up by the Chief Inspector of Factories in 1953.

Mr. H. Woods, C.B.E., H.M. Deputy Chief Inspector of Factories, has been appointed chairman and the other members are:—Mr. C. W. Hallett, Amalgamated Engineering Union; Mr. W. Prince, Amalgamated Union of Foundry Workers; Mr. E. Ayres and Mr. P. B. Higgins, Association of Bronze and Brass Founders; Mr. H. G. Barratt, Confederation of Shipbuilding and Engineering Unions; Mr. F. G. Burrell, O.B.E., and Mr. C. E. Watson, Engineering Employers' Federation; Dr. W. D. Buchanan, B.SC., M.B., CH.B., D.P.H., H.M. Deputy Senior Medical Inspector of Factories; Mr. J. Gardner, independent member; Mr. E. Tullock, Iron, Steel and Metal Dressers and Kindred Trades Society; Mr. A. Graham, Light Metal Founders' Association; Mr. R. W. Salt, National Society of Metal Mechanics; Mr. J. H. Barwell, J.P., and Mr. L. W. Gummer, M.I.MECH.E., National Brassfoundry Association; Mr. G. W. Chilton, North of England Brass Moulders' Trade and Friendly Society; Mr. W. Lapworth, Transport and General Workers' Union, and Mr. A. E. Mills, Zinc Alloy Die Casters Association. The secretary is Mr. W. B. Lawrie, H.M. Engineering Inspector of Factories.

The new Committee will continue the work of the older Committee which has been in existence since 1953 and which published its first report in 1957 and its second report in 1959. The first report contained a summary of the environmental conditions in the industry together with suggestions and recommendations for their improvement. It also referred to original work done by a technical sub-committee, the most striking part of which was the development of new melting furnaces. In the second report, the Committee dealt with existing health risks in the industry and certain potential risks inherent in new materials.

Since the publication of these reports two members of the technical sub-committee have put forward a fundamentally new conception in melting practice in an attempt to avoid excessive heat and to eliminate fumes in non-ferrous foundries. Pioneer work in one foundry has indicated a clear measure of success, so that one immediate problem before the new Committee will be the detailed examination of this original idea and its place in the theory and practice of melting and fluxing and casting many alloys.

Steel Foundries Committee

The Minister of Labour has also re-appointed the Joint Standing Committee on Health, Safety and Welfare in Steel Foundries. Appointed for three years, the Committee replaces and will continue the work of the Joint Standing Committee on Conditions in Steel Foundries which was set up by the Chief Inspector of Factories in 1952.

Mr. H. Woods, Deputy Chief Inspector of Factories, has been appointed chairman and the other members are:—Mr. W. Prince, Mr. R. H. Ward (Amalgamated Union of Foundry Workers); Dr. A. H. Sully (British Steel Castings Research Association); Mr. J. Bolton, Mr. D. Brown, Mr. A. G. Gilbertson, Mr. R. F. Horton, and Mr. G. R. Shaw (British Steel Founders' Association); Dr. W. D. Buchanan (deputy Senior Medical Inspector of Factories); Mr. J. Gardner (independent member); Sir Thomas Williamson (Iron and Steel Board); Mr. E. Tullock (Iron, Steel and Metal Dressers and Kindred Trades Society). The secretary is Mr. W. B. Lawrie, Engineering Inspector of Factories.

The work of a Dust in Steel Foundries Committee set up in 1943, which published its first report in 1944 and its second report in 1951, was continued and extended by a committee set up in 1952, whose report was published on August 14. The new Joint Standing Committee will, therefore, inherit a wide field of experimental work in various stages of completion. The subjects range over moulding practice, hot fettling methods, noise, X-ray surveys, the toxicity of dust, furnace fumes, the elimination of dust, the control of dust by local exhaust ventilation, respirators, dust estimations in foundries, and the assessment of the results.

Iron Foundries Committee

The Joint Standing Committee on Health, Safety and Welfare in Iron Foundries, recently re-appointed for three years, will replace and continue the work of the Joint Standing Committee on Conditions in Iron Foundries set up by the Chief Inspector of Factories in 1947. Mr. H. Woods is chairman of this Committee also and Mr. Lawrie, secretary. Other members are as follow:—

Mr. W. Prince and Mr. R. H. Ward (Amalgamated Union of Foundryworkers); Mr. H. A. Bonney and Mr. J. W. Gardom (Council of Ironfoundry Associations); Mr. E. C. Happold and Mr. R. C. Shepherd (Engineering Employers' Federation); Dr. W. D. Buchanan (HM Deputy Senior Medical Inspector of Factories); Mr. J. Gardner (independent member); Sir Thomas Williamson (Iron and Steel Board); Dr. E. Tullock (Iron, Steel and Metal Dressers and Kindred Trades Society); Mr. H. V. Shelton (National Light Castings Ironfounders' Federation), and Mr. J. Higham (National Union of Stove Grate and General Metal Workers).

The new Committee is the successor to two Committees, the Joint Advisory Committee which published its Report in 1947, and the earlier Joint Standing Committee which reported in 1956. The latter Committee also published two sub-committee reports, one on methods of reducing the amount of fume from oil-bonded cores (1950) and one on the drying of moulds by portable mould driers (1955). The Committees have examined many aspects of industry and original work has produced new methods of local-exhaust ventilation for pedestal grinders, mechanized knock-out plant and portable tools, as well as suggestions for the avoidance of dust and fumes in many other processes such as ladle drying and heating, wet decoring and the control of sand moisture content. A considerable amount of work which is still in hand may be expected to be continued by the new Committee.

IVE Anglo/Russian Exchange Visit

In August last year a delegation of British vitreous enamellers under the auspices of the Institute of Vitreous Enamellers went to the Soviet Union on an exchange visit. Their report is divided into two parts, the first dealing with general impressions and the second giving their account of a number of visits to Russian plants and technological institutes. This latter section describing as far as it goes the condition and future potential of the vitreous enamelling industry in the USSR will no doubt be of interest to readers and is published below in full. The first section of the report—not included here—confirms the picture of this vast and developing country that we have grown accustomed to of late. The report speaks of the "spontaneous friendliness shown by both the representatives of the host organization and casual acquaintances in hotels and even in the street." Probably the atmosphere in which the visit took place is best summed up in the following quotation from the report: "The Russians were eager to stress the achievements of their country rather than their ideology and they did not show any antagonism to capitalism. No restrictions were placed on the movements of the party and they were free to go wherever they liked."

The British delegation visiting Russia was made up as follow: Mr. J. Nicholls (chairman, IVE), Hurst Hill Enamel Company, Limited; Mr. J. D. Gardom (secretary, IVE); Mr. J. K. Hossack, Ferro Enamels, Limited; Mr. G. L. Hudson, Borax Consolidated, Limited; Mr. W. Richardson and Mr. S. E. A. Ryder, Stoves, Limited; Mr. C. E. A. Shanahan, Central Research Laboratories, Richard Thomas & Baldwins, Limited.

The visits usually had a set pattern, commencing with a short introductory talk on arrival, followed by an inspection of the works or laboratories and ending with a final discussion and question session. On their return to Moscow the party attended a final meeting with the State Scientific Technical Committee for a discussion on the visits and a general exchange of questions and information.

Leningrad Technological Institute

Established more than 30 years ago the Leningrad Technological Institute may be considered as intermediate between the ordinary technical institute and the university. It tends to supply top technologists for industry, while the universities produce research workers and teachers. It seems, however, that the universities, at least in Leningrad, were altering some of the courses to give a more practical bias. The Leningrad Institute specializes in chemical engineering and mechanical engineering for the chemical industry. Apart from the straightforward chemical engineering department, other departments included (*a*) glass and enamel, (*b*) binding materials (cement?), (*c*) ceramics, and (*d*) fire-resistant materials. During the full-time course of five years, students spend at least one month in a factory during the third year and at least two months in each of the fourth and fifth years. Three times as many students apply for admission as can be accommodated and selection is by a competitive examination, consisting of five papers, namely chemistry, physics, maths, Russian and another language. Normal admission is at the age of about 18, but students may enter up to age 35. Preferably, candidates will have spent two or more years in industry before applying for admission. Non-Russians are admitted and students come from Czechoslovakia, East Germany, Poland, and other East European countries; there are also several from China. Evening classes and correspondence courses are available. There are 4,500 full-time students and 400 instructors, including 40 professors. More than half the students live in hostels, the remainder either living at home or in lodgings in the city. Instruction is free and between 70 and 80 per cent. receive state maintenance grants.

Research

Senior students and staff carry out research work. The research programme consists of two parts (*a*) research sponsored by the State and financed by the State, and (*b*) research for industry, which is financed by industry. The total research programme is of the order of £400,000 p.a. by UK standards. The Institute works in close collaboration with industry and a factory may ask the Institute to carry out work on a particular programme. In such a case the Institute will examine the problem but will only accept it as a research project if it works in with the scheme of instruction. Industry also donates plant and apparatus to the Institute. In order to illustrate the close connection with industry, the president of the Institute is a leading Leningrad industrialist.

Enamelling

There is a course for enamellers in the department of glass technology, which at present is taken by about 15 students. The laboratory serving the enamelling department was not particularly well

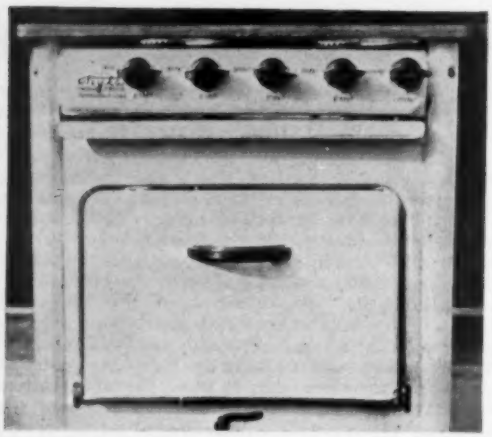


FIG. 1.—*Photograph taken by a member of the delegation of a four-burner cooker seen in a Moscow shop window. Hotplate top and extension were bare cast iron with no finish, and the burners cast iron with loose aluminium caps. Current lack of attention to the quality of the enamel finish was noted by the delegates by the presence of black specks and crude wiping-off along the edges of the loose crown tray and the door panel.*

equipped, having only small muffle furnaces with muffles approximately 6 by 8 in. Apparatus included a dilatometer apparatus, for thermal expansion, a thread-type viscometer apparatus and reflectometer apparatus. Outside there was a workshop containing an oil-fired crucible furnace for smelting trial batches of frit. Frit development is only taken so far and if a particular frit appears promising it is turned over to one of the factories to continue development. Titanium frits were developed at the Institute two to three years ago and work is now being done on lead-free and boron-free enamels. A considerable amount of work has also been done on direct application of cover coat but this has now been dropped because the manufacturers have decided it is easier to enamel with a groundcoat which results in a better job. Various sample placques displayed were not, by British standards, very good examples of enamelling. The gloss was very poor, thickness appeared rather heavy and the enamel was generally dull.

Chemical Engineering

The chemical engineering department appeared to be well equipped with apparatus and semi-scale plant for instructing students in fundamentals. The following plant was noticed amongst others:—(*a*) Distillation columns, (*b*) heat transfer, (*c*) pump design and testing, (*d*) fluid flow (Reynolds), (*e*) oscillating-rectifier column, (*f*) vacuum filtration, (*g*) filter presses, (*h*) evaporation and (*i*) vacuum evaporation. Until recently the chemical engineering department had been responsible for instrument technology but this is now being transferred to the mechanical engineering department.

Generally speaking, the plant available in the chemical engineering department for the instruction of the students, was comparable with that to be seen at the chemical engineering department at Loughborough College, but semi-scale plant in glass, which is a feature at Loughborough, was completely absent at Leningrad. Instrumentation at Leningrad was definitely not so good as at Loughborough.

Gasapparat Factory No. 4

Established about 12 years ago as a new industry in Russia, with little knowledge and no experience, the Gasapparat factory now produces 600 to 700 cookers and 200 instantaneous water heaters per day. The majority of the factory works two shifts and the enamel department three shifts per day, with a working week consisting of five 7-hr. shifts, with a 5-hr. shift on Saturday. Appliances are supplied all over the USSR and, as many towns have recently been supplied with natural gas for the first time, the demand is tremendous. Some towns still use manufactured gas, usually produced from oil, and some are using butane.

The unsuitable buildings are shortly to be redesigned and extended. Cold-rolled sheet is used, although the firm has been trying to use hot-rolled steel to reduce the cost but have experienced fish-scale trouble. Frit is now produced in an oil-fired smelter which will shortly be changed to gas firing. Usage of enamel is about 70 tons monthly, which the frit plant produces in about two weeks. The frit plant was not working during the visit. A nickel groundcoat appeared to be in use while all the cover coat was titanium type. There is 6 to 7 per cent. of boron in the groundcoat and 20 per cent. in the covercoat but staff are trying to reduce boron content. They do not maintain any enamel research of their own but work in close callaboration with the Leningrad Scientific Technological Institute. There is no cast iron used on the cookers or water heaters and thus there is no cast-iron enamelling, but there was a small test room or laboratory for development work on appliances.

Standards

There are State standards laid down to which appliances must conform, including a requirement that CO/CO_2 must not exceed 0.005. The burners —aluminium die-castings with loose die-cast aluminium heads—were well made and gave good flames, although the spreading flame-type head was approximately 2½-in. below the pot and would probably not give a very-high thermal efficiency. The taps were of the push-in lock type with a different colour for the oven tap. The kettle rests were circular with four prongs made from heavy-gauge sheet metal. The construction generally is built

round four sheet-metal corner pieces, which extend from hotplate right down to the floor, forming the legs, and are positioned outside the panels. The oven is very small, approximately 12-in. wide by 6-in. high and 15-in. deep, with a drop down door. There is no grill and the hotplate is equipped with three or four boiling burners. The oven has two side burners with a loose-base tray. The oven interior is finished in groundcoat enamel only and the hotplate is black cover coat. The State standard for cookers demands an all-vitreous-enamel finish. The price of cookers ranged between £6 and £9 and the water heater cost about £9 10s. 0d. The water heater appeared to be a very sound job, the burner and valve chamber consisting of a single aluminium pressure-die-casting which was an outstandingly-good job. There were five tubes incorporated in the burner casting and these were saw cut to form the burner ports. It was stated that it was the aluminium die-casting which enabled the factory to produce the water heater so cheaply.

Groundcoat

All groundcoat application was by dipping and draining, the dippers turning the pieces around several times before placing them flat on a conveyor dryer. The Russians stated that groundcoat thickness was 0.005-in. (which was confirmed with an Elcometer) and that the covercoat also was 0.005-in. A number of pieces in the shop and in a stack ready for despatch were checked and the following figures were noted for total thickness:—0.012, 0.014, 0.020, 0.018-in. and one greater than 0.020-in. 94 per cent. of white panels were said to receive only one covercoat and 6 per cent. were re-operated but the thickness values found do not confirm this, although the standard of inspection was so low that 94 per cent. would not have been surprising. None of the finished panels seen would have passed inspection in this country, due to boiling or handling marks, while the gloss was very poor by British standards. It was stated that the output of the shop was 1,500,000 sq. metres per year. Groundcoat was fired at 900 deg. C. for 1¼ minutes and covercoat was fired at 800 deg. C. for 1½ minutes. All pieces were grease burned before pickling in two electric furnaces approximately 7 by 4 ft. and fusing was carried out in four electric box furnaces approximately 8 by 4 ft. The Russians considered that the acid resistance of their titanium enamel was not very high. Assembly was carried out on a power-driven conveyor delivering 55 cookers per hour. Ovens were lagged with slag wood pads. The electric furnaces had coiled wire elements in the sides and bottom.

Operators in the plant earned the equivalent of £40 per month, also bonuses under the competitive schemes. It seems that all State built flats have a gas cooker installed as standard equipment. A few are sold to the public through shops by the Board of Trade. Electric cookers can only be obtained by buying one's own. Under these circumstances, of course, production of electric cookers is only a small fraction of that of gas cookers.

Lenkimpisthekombinat

Having been told that the above factory produced kitchen ware and enamel trays for the food industry and lids for food containers, etc., the party was surprised to find that the kitchen ware was in the form of steel pressure vessels up to about 6-ft. dia., some of which may have been used in food preparation but which were probably mainly used in the chemical industry. They were lined with very-highly-resistant special enamel which is usually described in this country as a glass lining. The plant had been developed since the war and demand for its products is rising rapidly. The equipment was fabricated from heavy plate using gas and electric welding. The pieces were first scurfed by hand grinders and then blasted with quartz sand in a shotblast room and using protective equipment similar to that used in England. The one fusing furnace was a semi-muffle about 12-ft. cube. The charging machine had complete remote control. The factory produced it own frit in a rotary smelter with a capacity of 300 kg. and usage was about 7 tons per month. The enamel contained titanium and boron. The factory also has close contact with the Leningrad Technological Institute and frequently has students from the Institute working in the plant. The furnace is heated by special quality sulphur-free diesel oil.

(to be continued)

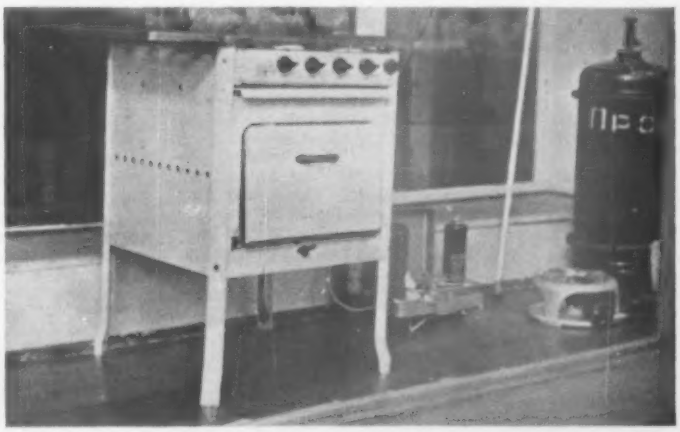


FIG. 2.—*Alongside the cooker in Fig. 1 were seen a liquid-gas hotplate, a single boiling ring and a liquid-gas container.*

American Letter

Back to Cast Iron in US Automobiles?

In an article entitled "New Cheaper Iron Alloys in view for Engine Parts," which appeared in the US magazine *Automotive News* dated June 26, Mr. Callahan, engineering Editor, deals with research being carried out to produce new and "lighter"* cast irons for the US automobile industry. What follows is an abstract of the article; it carries a stage further the American controversy (previously reported) as to the relative merits of cast iron and aluminium in the automobile field.

Hush-hush Test

A small foundry in upper Pennsylvania recently received a most mysterious order. It was asked to pour spheroidal-graphite iron into a large mould concealed in a metal box which was sealed and welded shut. Even before the metal had cooled, the box was loaded on a truck and taken away. When the foundry foreman asked the escorting engineer if he didn't want to see whether the casting turned out all right, he was told that if it wasn't satisfactory, he would be back. Subsequently it was learned that this casting was an automobile engine-block and that it was being taken to a General Motors' laboratory.

This story typifies the large-scale and accelerated programmes now under way in the US automobile industry, which are expected to result in a dozen or more major automobile components being produced from new and "lighter" cast irons. General Motors, the group which earlier fostered the adoption of aluminium engines and other components, is now, it appears, swinging back into the use of improved iron alloys. US iron and steel producers have awakened to the danger of losing their largest customer and are, it is claimed, developing new iron alloys which will do a better job for the same or less money.

Aluminium Too Costly?

A General Motors' general manager told the author of the article referred to that there was only one reason why his company had backed off from the use of large aluminium engines for their future car production and why the current smaller aluminium engines were not making the grade—they cost too much. The development programmes being carried out at the present time will be revealed later this year when several new engines are introduced. Although new engines will be of conventional grey iron, the true results of research will not appear until the latter part of 1962 and later, when the new "thin-wall" iron engines make their appearance. Thin-wall engine-blocks are expected to combine both the cheapness of iron and to have weights not incomparable with those of aluminium. General Motors have now concluded that it is immaterial what material is used in an engine block or other component, so long as it is the lowest priced, most economical to operate and best performing, and it has become apparent, continues the article, that aluminium has no particular merchandizing value.†

Included in the "lightweight" irons now being studied for use in engine blocks and other components are malleable iron, s.-g iron, various nickel-containing irons and several other iron alloys.

Ford Motor Company's Production

In 1960, the Ford Motor Company (US) produced an estimated 98,000 tons of s.-g iron, more than half of all the US production of this material. S.-g iron engine-block programmes are reported to be well forward at Ford's, General Motors' and Studebaker-Packard. The Ford organization which completely avoided aluminium engines, is reported to be considerably ahead in this work.

Although the definition of a thin-wall block differs from company to company, it usually means a block the thinnest walls of which are about 1/10-in. thick (compared with 117-in. thick in conventional grey-iron blocks) and with other wall-thicknesses reduced proportionally. To produce such a block, two principal problems must be solved—selection of suitable metal and development of suitable casting equipment. Compared with grey iron, the metal must be stronger, less brittle, and have more ductility, and above all, it must be less susceptible to chill, solidify slowly and have greater fluidity.

Research into Equipment

Although not insurmountable, one major obstacle to the switch to s.-g iron blocks is the lack of equipment which would permit holding the necessary low dimensional tolerances. The principal problem is to produce sand moulds and sand cores which will be of sufficient hardness and which will hold their dimensions for a long-enough period. Considerable research is being carried out at the present time to develop more-rigid greensand moulds and, in addition, some US companies are using the new "hot-box" method of making sand cores, whereby the core is cured in the corebox. Overall, it is expected that any swing to s.-g iron will increase the costs of foundry labour, though reducing machining and assembly costs. The weight-saving target in the engine-block programme being carried out is 25 to 30 per cent. Thus, if a grey-iron block weighed 200 lb., its s.-g iron counterpart would weigh 150 to 160 lb., a similar aluminium block weighing around 80 lb.

Other Advantages Claimed

Other advantages claimed for s.-g iron over aluminium are that an s.-g iron block has much less porosity, reducing the need for impregnation, and it has fewer machining problems. Several US automobile manufacturers have been producing s.-g iron blocks experimentally for more than a year and it has been reported that these have passed their machining tests and are now being tested on dynamometers and in cars. Although not conclusive, the results are favourable, so far, it is stated.

Amongst other automobile components now being considered for production in s.-g iron are crankshafts (already produced by Ford's), differential carriers, engine output shafts, steering-gear carriers, door-hinges and brake pedals. In addition, some interest is being shown in an s.-g iron one-piece brake-drum and hub and a one-piece flywheel and starting gear. The biggest move in this direction is expected to come from Ford's which is shortly expected to switch to s.-g iron for all parts currently being produced from malleable iron.

Mr. CECIL F. HURST, deputy chairman of Samuel Osborn & Company, Limited, has been appointed assistant managing director.

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* It is clear that in this context "lighter" has no connection with specific gravity but means material of greater strength per lb., permitting reduced section thicknesses for components.

† It will be remembered by JOURNAL readers that a very similar statement emanating from the (American) Ford concern was reported some time ago.—*Editor.*

" Bow Bells " will ring again

By . . .
Ursula Powys

The illustration shows the re-cast bells, after tuning, at the Whitechapel Bell Foundry of Mears & Stainbank, Limited.

On the night of May 11, 1941, the harsh clangour of bells crashing to the ground was heard above the din of a city under bombardment. It was Cockney London's own church of St. Mary-le-Bow in Cheapside being reduced to a shell for the second time in its long history, and the famous " Bow Bells " were irreparably damaged. The Great Fire of London in 1666 had caused its first destruction, the church having been completely rebuilt by Wren at the cost of £15,400, fourteen years later.

Salvage

When daylight came after the bombing, it was discovered that the beautiful tower, although damaged, was still standing—that two bells were lying at its foot, one had lodged midway, and the remainder were wedged on top of it. The difficult and dangerous job of salvage was begun, each broken fragment being carefully collected—with the exception, that is, of one piece which was reverently borne away by the London Division of the Army to be their mascot. It was then decided to bury the sad remains under the Church crypt which was intact. Only three men in authority knew of the whereabouts of the cache, and the secret was well kept until the war was over. The task of casting a new ring of twelve bells from the original metal was assigned to Mears & Stainbank, of the Whitechapel Bell Foundry—a natural enough choice, as the foundry would be dealing with familiar material, the original bells having been cast on the premises in 1738.

Re-casting

The damaged bells and all the fragments (including the mascot from the London Division) were introduced to the furnace and the new bells were cast; but difficulties arose. Funds were insufficient to instal the bells, and so for five years they have lain in the courtyard of the bell foundry. At last help came, and it is now almost certain that they will be hung in December this year, and Londoners will hear Bow Bells ring again in 1962.

An alteration to the original specifications has been made. The new tenor bell (the largest) weighs 42 cwt., eleven hundredweight lighter than its predecessor. Because the heavier bell encroached on the windows of the tower, it was considered more suitable to cast the lighter one which will swing within the four walls.

" Stocking down," or the fitting of the headstock to the crown of the bells has to be undertaken before they are mounted in the bell-frame—in this instance, the bell-frame will be constructed of Burmese hardwood, impervious to the onslaughts of insects. It will be a proud moment indeed, for those ringers selected to raise the bells for the first time and to ring the first " method."

Exporters need More Help

More help is the prime need of the majority of exporters. This is one of the findings of the initial results of a postal survey amongst the businessmen who read the London School of Marketing's *Export Guide*. Six out of every ten said they needed more information on selling abroad and this was true of the larger companies as much as of the small.

The businessmen were asked to assess the value of export services available to them. The Board of Trade, which is used by nearly every exporter, is rated "excellent" or "good" by three-quarters of those using it. Assistance given by industrial, commercial and trade associations, banks and Chambers of Commerce—patronised by three-quarters of exporters—are not considered quite as useful but the rate is still satisfactory. The Export Credit Guarantee Department, however, used by two-thirds of those replying, is only judged "excellent" or "good" by not quite half of these exporters. British Embassies overseas, administered by the Foreign Office, are resorted to by two-fifths of exporters of whom 70 per cent. regard their services as "adequate" or "poor."

One of the striking features of the habits of businessmen, in the light of their desire for more information, is their sparing use of market research techniques and agencies. Less than one-fifth of firms had employed them and the majority of these seemed dissatisfied with the service they received. The survey, based on questionnaires sent out with the July issue of the *LSM Export Guide*, reveals that the type of industry does not greatly affect the general pattern of replies to the LSM questionnaire but size of firm makes a considerable difference both to the use and opinions of export services. Trade associations and banks are less highly rated by small firms while the ECGD obtains the lowest rating from the very large firms. The Board of Trade is most appreciated by the medium-size firms.

Specific examples of the type of information of which exporters would like to have more, are market information (requested by 29 per cent.), details of competitors' activities (18 per cent.), help in finding good agents (10 per cent.), market research (10 per cent.), and quicker and more detailed statistics (7 per cent.).

The *LSM Export Guide* survey underlines the fact that the source most exporters would use for information on overseas selling is their local agent—45 per cent. of exporters would obtain it in this way. Sixteen per cent. would acquire such information by visiting the country, while 15 per cent. would approach a government department, *i.e.*, the Board of Trade. The survey also shows that market research agencies, banks, Chambers of Commerce and trade associations are rarely considered as important sources for such information.

Foremen on Wheels

The foremen of the British Aluminium Company, Limited, at Bainsford, Falkirk, have been provided with tricycles for quick and easy transport from one department of the factory to the other. "To begin with everyone laughed at the idea of a foreman going through the works on a three-wheeler," said Mr. Bob Jones, warehouse foreman. "But in a short time we all realised what a boon the tricycles were. They save both time and legs. The factory is so large that previously we were walking miles each day. Now someone calls on the telephone or we are wanted in another department and off we go with no effort at all." The prospects of future increased employment in this Falkirk factory are rosy. Extensions which are to cost £10,000,000 have been announced, and contracts will be placed in about a year's time.

Dorman Long place Orders

Details of the first major orders to be placed in connection with the present stage of the development programme of Dorman Long (Steel), Limited, have now been released. The biggest contract has been awarded to Davy & United Engineering Company, Limited, Sheffield, who will build and supply a 48 by 130-in. high lift slabbing and blooming mill which will cost £1,300,000. It is intended to roll 25,000 tons of ingots weekly for the production of blooms and slabs, and the new mill will be sited alongside Dorman Long's existing universal beam mill at Lackenby. Slabs produced will supply the present wide plate mill at the company's Redcar works and the blooms needed to cope with the company's increasing needs for medium and light finishing mills. The mill will also supply in due course a new universal four-high plate mill capable of producing 60-in. wide plates with rolled edges.

Priest Furnaces, Limited, of Middlesbrough, are to supply the soaking pits valued at approximately £700,000, while Associated Electrical Industries, Limited, will be responsible for the blooming and slabbing mill electric drive. This order is valued at approximately £450,000.

Orders are to be placed shortly for auxiliary motors for the mills, the control gear, switch gear and electrical distribution equipment. Ingot stripping and soaking-pit cranes to the value of approximately £400,000 are to be supplied by the Wellman Smith Owen Engineering Corporation, Limited. The bridge department of Dorman Long will carry out all the foundation work for the mill. Mill buildings are to be supplied and erected by Dorman Long (Bridge & Engineering), Limited, and two Dorman Long subsidiary companies, Tees Side Bridge & Engineering Works, Limited, and Redpath Brown & Company, Limited.

Sheepbridge Engineering Prospects

With orders on hand at March 21 last substantially higher in value than at any previous year-end, Lord Aberconway, chairman of Sheepbridge Engineering, Limited, electrical engineers and manufacturers of colliery machinery, of Chesterfield (Derbyshire) says that prospects for the company in the current year "look good," but he points out that the profitability of the business is highly susceptible to volume, and adds, that in view of the country's critical economic position, the directors regard the future with caution.

Nevertheless, subject to any general deterioration in trading conditions, increased turnover should offset narrower trading margins and the overall profit should be maintained. Lord Aberconway says that the increase in production last year was made possible largely by the decision to incur greater expenditure than usual on capital equipment. Without this expenditure, demands, especially from the motor trade, could not have been met.

Institution of Metallurgists Examination

The Institution of Metallurgists announces the following results of the examination for associateship and licentiateship, 1961, held in July last at 14 centres in the UK and 12 centres abroad:—*For Associateship:* Of the 341 candidates, 142 passed and 119 were referrred in one subject; the remainder failed. *For Licentiateship:* 196 of the 731 candidates passed and 132 were referred; the remainder failed.

Equipment and Supplies

Pressure-die-casting Machine

A report on tests of the Triulzi* 2,200-ton (cold chamber) pressuring-die-casting machine has recently been issued. Claimed to be the largest pressure-die-casting machine (Fig. 1) in the world, it was producing the aluminium four-cylinder block for the 2½-litre Volga car for Russia. Now that these trials are complete, the machine is being shipped to Gorkii City, USSR, complete with die. The casting itself (Figs. 2 and 3) weighed 22 kg. with slug and runners, and 18 kg. when trimmed. Cast-iron cylinder-liners will be pressed in after machining of the block and in the final production conditions, it is intended to heat-treat (stabilize) the castings and all castings will be impregnated on the production line. The aluminium alloy used for the trials contained Ni 0.02, Cu 0.119, Si 8.75, Mg 0.3; Fe 0.4 and Mn 0.4 per cent. In Russia it is intended to use a different alloy, similar to LM9, so that the injection-plunger speed can be increased without danger of welding metal to the die. The composition of this metal is expected to be Al, with Si 12, Mg 0.5, Mn 0.5, and at least 0.8 per cent. of added Fe.

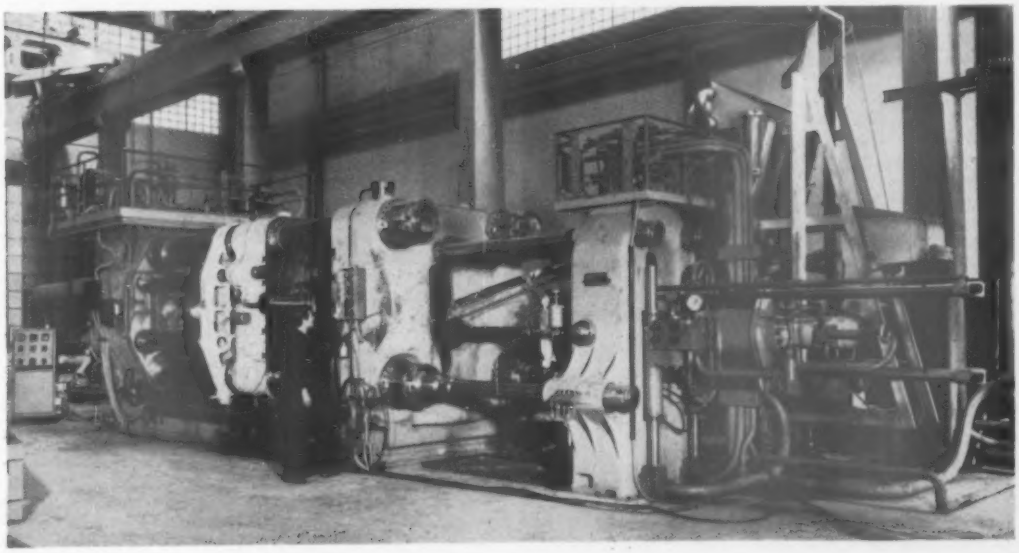
Die and Pouring Set-up

The 14-ton die was made in "Marathon" steel E38, hardened to 45 Rockwell, nominal composition: C 0.4, Si 1.0, Mn 0.5, Cr 5.6, Mo 1.0, and V 0.5 per cent., and it is reported as having taken 15,000 man/hours to produce at Fonderpress, Bologna, who co-operated closely with the Russian designers and Triulzi in planning this project. Die temperature was thermostatically controlled to operate at 230 deg. C. (taken in the middle of the cavity), an air blast being applied during the machine cycle. A graphite-and-oil die-lubricant was employed. The casting itself was gated low on the inner edge of the flange to which the sump is fixed, the gate area being 4.6 sq. cm.

* Manufactured by Triulzi, of Milan, London agents Alexander Cardew, Limited, 2, 3 and 5, Studio Place, Kinnerton Street, London, S.W.1.

FIG. 2.—*Casting about to be removed from the transfer mechanism—the transfer being part of the machine's automatic cycle.*

FIG. 1.—*Overall view of the 2,200-ton Triulzi pressure-die-casting machine, showing the automatic ladling furnace (rear, r.h.s.) with its launder leading down to the cold chamber.*



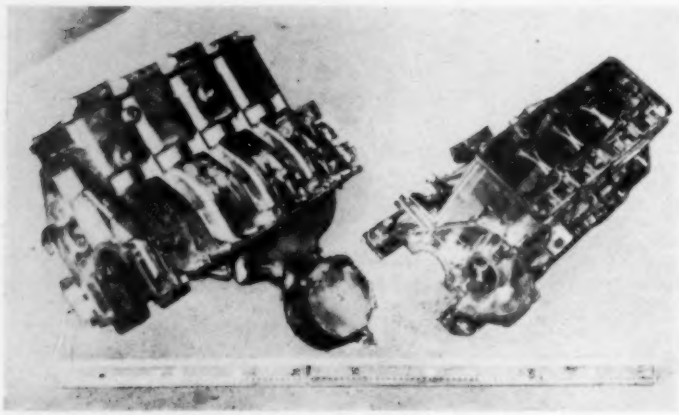


FIG. 3.—*Two views of Volga cylinder-block castings taken from the new Triulzi die-casting machine, with runners, etc., attached (compare size with metal rule).*

Trial Details

In the machine trials in Milan the plunger speed was relatively slow, but it is reported that this will be speeded up in Russia when the different alloy—with the added iron content—is employed. The pressure on the metal employed was reported as 890 kg. per sq. cm. (about 12,650 lb. per sq. in.). With a plunger of 150 mm. diameter, an injection force of 150 tons was used on the ram. This would suffice for a casting area of 2,500 sq. cm. (375 sq. in.), considerably more than the actual area of the cylinder-block in question. In Russia, it is intended to use only three operators—one operating, a second removing the casting from the transfer system, and a third looking after the "Dosomatic" automatic ladling furnace. Table 1 gives machine dimensions and capacities.

TABLE 1.—*Pressure-die-casting Machine Specification.*

Locking force			2,200 tons
Injection force	min.		80 tons
	max.		170 tons
Platen dimensions	(overall)		78¾ by 82¾ in.
Die height	min.		27½ in.
	max.		47¼ in.
Die height adjustment			19¾ in.
Opening stroke			59 in.
Injection capacity			Over 100 lb. aluminium
Idle cycles			120 per hr.
Overall size			650 by 146 by 209 in.
Weight			113 tons

The minimum cycle recorded during the test was approximately four min., with an actual cooling time of 35 sec. However, much time was spent in ensuring thorough lubrication of the die; when the die is properly run-in the Russians are satisfied that they can get 20 castings per hr. from it. The cycle of the machine was automatically controlled from clamping through to transfer of the casting (including dosing of the metal into the cold chamber core movement and injection).

The actual transfer mechanism consists of a fabricated frame, pivoting on the outer edge of the die opposite to the machine operator. This is driven by rack-and-pinion to come into position just below the cavity on the moving platen, so that the ejectors push the casting out on to the frame. The rack-and-pinion mechanism then swings the casting clear of the die. The locking system of the machine, consists of four radially positioned wedges, locking into an annular ring around the main column at the end of the clamping stroke. This is followed by pressurization of a very small stroke ram at the front of the main column (stroke under 1 in.) As the main column is moved forward by jack-rams, this system is highly conservative with hydraulic pressure and incorporates a positive mechanical lock in the form of the radial wedges.

The central hydraulic plant consisted of two pumps delivering 53 gall. per min. and three 1,000-litre accumulators, with a servo-controlled unloading valve for the pumps and a low-pressure check-valve for the accumulators. The injection pressure of the machine is said to be variable between 170 tons maximum and 80 tons minimum. The tie-bars of the machine are 11-in. dia.

Two further machines of this type are scheduled for delivery to the Volga factory in Russia later, and it is said that plans for two V8 cylinder-blocks are already underway, and that these castings can be produced on the same machine.

Spectrometer

In the June 30, 1960, issue of the JOURNAL, a full technical description was printed of an X-ray automatic fluorescent spectrometer (manufactured by Solartron Industrial Controls, Limited, Farnborough, Hants.) installed in the works of Yorkshire Engineering Supplies, Limited, of Leeds. A new model has now been designed which, unlike the one described earlier, can analyse for phosphorus and other elements, though carbon is not yet included. It is interesting to note that one of the new units, type XZ-1030, is being installed also in the works of Y.E.S., as it caters for all elements of greater atomic number than 12.

Flame Controllers

Ether, Limited, Caxton Way, Stevenage, Herts, have developed a range of flame controllers (series 704) for safely igniting and monitoring multi-burner installations in industrial concerns. They are controlled by fully transistorized, plug-in circuitry and a.c. coupled amplifier—for use with gas-fired and oil-fired burners or burners working on a combination of both fuels. Their mechanism discriminates between flame and flame-radiation and is unaffected by the latter. They are available for controlling up to six flames at once, and the absence of one or more flames indicates an alarm condition.

Starch: In January, Starch Products, Limited, Slough, acquired a controlling interest in W. Caldwell & Company, Limited, at which time the name was changed to Starch Products (Scotland), Limited, and new premises were established. The new factory is located at Port Downie Works, Camelon, near Falkirk, where the wide range of products being manufactured includes dextrines, British gums, a variety of pregelatinized starches, cold-water-soluble adhesive powders, "cook-up" adhesive powders and paste flours, as well as a complete range of vegetable and synthetic-resin adhesives.

SECTION DEVOTED TO THE TECHNOLOGY OF PRODUCING DIMENSIONALLY-ACCURATE CASTINGS

Alloys for . . . Aircraft Gas-turbine Rotor Blades*

By E. Glenny, B.Sc., F.I.M.

There is little doubt that conventional alloys are closely approaching the limit of increase in temperature for present levels of load-carrying ability. Service temperatures are approximately 80 per cent. of the melting point of currently used alloys. Nevertheless, metallurgists in the high-temperature alloy field have continued to confound the prophecies that nickel-base compositions in particular have reached the "end of the line." This paper is a review of the properties and characteristics of alloys that have been developed for aircraft gas-turbine rotor blades during the past three to four years.

During the past 15 years the development of aircraft gas-turbines with greater thrust (*i.e.* turbo-jet engines) and higher power output (*i.e.* turbo-propeller engines) has resulted in the use of higher gas-temperatures. For the rotor blades it has been realized that there is a temperature limit beyond which conventional alloys based on nickel or cobalt would be inapplicable. Although higher turbine-inlet temperatures can be obtained by internal air-cooling of the blades to the extent that the permissible metal temperature is not exceeded, it is preferable to use uncooled blades. The usefulness of high-melting materials *e.g.* ceramics,[1] cermets[1] (ceramic/metal mixtures) and refractory metals[2] that maintain their strength at higher temperatures has and still is being investigated. However, such materials, possessing similar or greater strength at higher temperatures than conventional blading alloys, and also adequate resistance to creep, fatigue, corrosion, erosion, thermal shock and impact, are not immediately available.

Alloy Development

In Fig. 1, the progress of development during the last 25 years of creep-resistant alloys used or intended for rotor blading is expressed[2] in terms of the temperature for fracture in 100 hours at a stress of 8 tons per sq. in. The remarkable feature of this development is that the rate of progress has slightly increased in recent years. In the late '40s, cast cobalt-based alloys were developed with superior stress-to-rupture properties to nickel-base alloys, but since then, the latter, in the cast or wrought condition, have been dominant. The most-recently developed cobalt-base alloy, F484 (see Appendix 1†) is appreciably inferior, as can be seen from Fig. 1, to contemporary cast nickel-base alloys. It is also evident from Fig. 1 that cast alloys have maintained a temperature advantage of about 50 deg. C. over wrought alloys. The latter have offset this advantage with better ductility and impact strength as well as superior tensile properties at room temperature.

† See page 301.

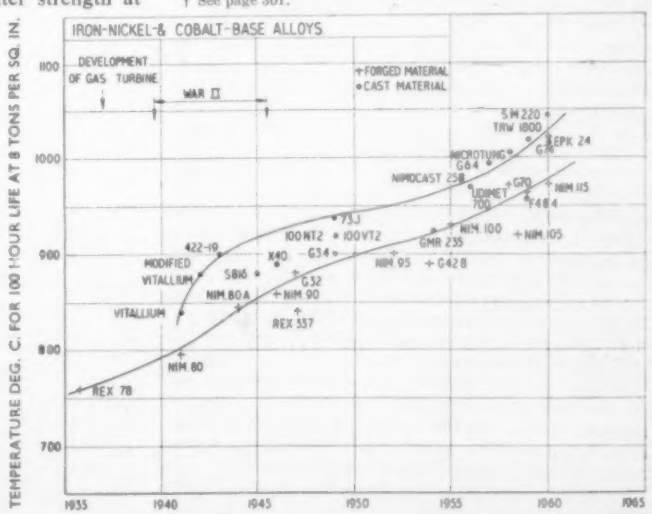


FIG. 1.—*Progressive development of high-temperature alloys used or intended for aircraft gas-turbine rotor blades.*

* Paper presented to the third annual conference of the British Investment Casters' Technical Association. The Author is attached to the National Gas Turbine Establishment of the Ministry of Aviation.

Alloys for Gas-turbine Rotor Blades

In the United States, both cast and wrought alloys have been and are being used for rotating blades. On the other hand, British engines have, until recently, employed only wrought alloys of the Nimonic series for the turbine rotor blading, Nimonic 105[4] being in current use. This preference for hot-worked alloys was mainly because the continuous development of the Nimonic series has successfully fulfilled the engineering requirements and because insufficient effort had been made to develop casting alloys and casting techniques to provide the desired level of properties. Also, as Taylor[5] has pointed out, the fear of excessive scatter in properties and of inadequate ductility had prejudiced the consideration of castings. For engines in which the ratio of alternating to steady blade stresses is high, hot-worked alloys have been preferred. Recently, however, the rupture-strength advantage of cast over wrought alloys coupled with the compositional control afforded by vacuum melting has encouraged Bristol Siddeley Engines,[5] Limited, to use a cast nickel-base alloy (G64)[6] in the first-stage rotor-blading of Proteus engines. Approximately 100,000 hours total running experience has now been accumulated without the occurrence of any creep failures or creep cracks. The longest running period for a particular set of blades in service is over 2,500 hours.

Alloy Compositions

The compositions of the best commercially-available alloys developed during the period under review are given in Table 1. These alloys are all nickel-based and do not differ greatly in composition. All contain less than 0.2 per cent. carbon, 10 to 16 per cent. chromium, 4 per cent. or more of aluminium and 3 per cent. or more of tungsten or molybdenum. Most contain titanium up to 5 per cent., with small quantities of boron and sometimes zirconium. Several contain 10 to 20 per cent. cobalt, while a few possess 1.5 to 2.5 per cent. niobium. The maximum iron content is usually specified for each alloy. The compositions of the cast alloys are not limited by the necessity for hot-working and so their content of alloying elements is greater than for the wrought alloys. The high-temperature strengths of all these alloys is partially due to the precipitation of the intermetallic phase Ni_3 (Ti, Al) by prior heat-treatment (see Table 2) or in service, and partly to stiffening of the nickel-chromium solid solution with aluminium, cobalt, tungsten or molybdenum. Other factors being equal, the larger the difference between the atomic diameters of the parent metal and the alloy addition, the greater will be the recrystallization temperature and therefore the higher the temperature at which strength can be maintained. Increasing use is therefore being made of alloying additions such as tungsten and molybdenum. Minute addi-

TABLE 1.—*Nominal or Typical Compositions (per cent.) of Cast and Wrought Nickel-base Alloys.*

Alloy	C	Cr	Co	Al	Ti	Mo	W	Cb	Fe	B	Zr	V	Ref. No.
Nimocast 258	0.2	11	20	5.0	3.7	5	—	—	1.5 max.	0.008 to 0.03	—	—	7
Nimocast 713V	0.1	14	1.0 max.	6.2	1.0	4.5	—	2.5†	1.5 max.	0.005 to 0.015	0.05 to 0.12	—	7
Inconel 717C	0.12	11	8	7.5	1.0	4.5	—	2.0	—	—	—	—	3
G 64	0.12	11	—	6.05	—	3.0	4.0	2.0	1.5 max.	0.25	—	—	6
G 67	0.12	16	—	6.0	1.0	3.0	4.0	—	4.5 max.	Added	—	—	8
TRW 1800	0.09	13	—	6.0	0.6	—	9	1.5	—	0.07	—	—	9
Nicrotung	0.10	12	10	4	4	—	8	—	—	0.05	0.05	—	10
G 74	Not published												
DCM	0.08	15	—	4.0	3.5	5.0	—	—	5.0	0.07 to 0.09	—	—	12
EPK 24 (IN 100)	0.18	10	15	5.5	4.5*	3	—	—	—	0.01 to 0.02	0.05 to 0.1	0.5 to 1.0	13
SM 220	Not published												
Nimonic 105	0.2 max.	15	20	4.6	1.2	5.0	—	—	1.0 max.	—	—	—	4
Nimonic 115	Not published												
Udimet 700	0.15 max.	15	18	4.25	3.5	5.0	—	—	1.0 max.	0.1 max.	—	—	15
G 70	0.1	15	19	4.0	3.5	6.0	—	—	—	added	—	—	11

* Recently increased to 5 per cent. † Nb + Ta.

TABLE 2.—*Density, Heat-treatment and Suppliers of Alloys under Review.*

Alloy.	Density, g. per cu. cm.	Condition of use.	Heat treatment.†	Supplier.	Ref. No.
Cast.					
Nimocast 258 ..	0.286	Air or vacuum-cast..	As-cast *or* 2 to 4 hr. at 1,175 deg. C., transferred to furnace at 1,050 deg. C, held 16 hr., A-C; aged 16 hr. 850 deg. C, A-C	Henry Wiggin & Company Limited	7
Nimocast 713 ..	0.286	Air or vacuum-cast..	As-cast, *or* 2 hr. 1,170 deg. C., A-C ..	Henry Wiggin & Company Limited	7
G64	0.288	Vacuum-cast ..	6 hr. 1,100 deg. C., A-C	Jessop-Saville Limited ..	6
G67	0.288	Vacuum-cast ..	6 hr. 1,100 deg. C., A-C	Jessop-Saville Limited ..	8
TRW 1800	0.298	Vacuum-cast ..	None	Thompson Remo Wooldridge, Inc., Cleveland, Ohio	9
Nicrotung	0.296	Vacuum-cast ..	None	Westinghouse Electric Corporation, Pittsburg	10
G74	—	Vacuum-cast ..	6 hr. 1,100 deg. C., A-C	Jessop-Saville Limited ..	11
DCM	0.286	Vacuum-cast ..	1 hr. 1,150 deg. C., A-C; 2 hr. 1,065 deg. C., A-C; and 4 hr. 843 deg. C., A-C	General Electric Company, Detroit	12
IN 100 (EPK 24)* ..	0.275	Vacuum-cast ..	2 hr. 1,177 deg. C., A-C	Henry Wiggin & Company Limited	13
SM 220	0.330	Vacuum-cast ..	Not known	Sierra Metals	11
Nimonic 105.. ..	0.289	Wrought	4 hr. 1,150 deg. C., A-C; 16 hr. 1,050 deg. C., A-C; 16 hr. 850 deg. C. A-C	Henry Wiggin & Company Limited	4
Nimonic 115.. ..	0.283	Wrought	1½ hr. 1,200 deg. C., A-C; 6 hr. 1,050 deg. C., A-C	Henry Wiggin & Company Limited	14
Udimet 700	0.286	Wrought (rolled or forged)	2 hr. 1,150 deg. C., A-C; 4 hr., 1065 deg. C, A-C; 24 hr. 843 deg. C. A-C; 16 hr. 760 deg. C., A-C	Kelsey-Hayes Co. Utica 4, New York	15
G70	0.288	Wrought	Confidential	Jessop-Saville Limited ..	11

* Developed and marketed as IN 100 by International Nickel Company Limited and marketed as EPK 24 by supplier.
† These heat-treatments are subject to alteration by the supplier.

tions of boron or zirconium serve to modify the grain-boundary structure and considerably enhance the rupture life, as shown in Table 3.

Method of Manufacture

The recent rapid progress in alloy development has been due to the impetus given by vacuum-melting. Its utilization was largely due to the desire to increase the titanium and particularly the aluminium contents of wrought alloys without incurring the oxide films and nitride inclusions that are troublesome during the hot-working of air-melted alloys. Although its primary role is to reduce the gas content and eliminate the slag blanket required in air-melting processes, thereby giving greater freedom from harmful impurities, the improvement in properties is mainly due to superior control of composition. In addition to increased titanium and aluminium content, it permits control of trace additions such as boron and zirconium while the virtual elimination of manganese and silicon has undoubtedly contributed to increased ductility. Thus improvements in properties are not simply due to the vacuum-melting process *per se* but to significant modification of the minor alloying constituents. Richmond[18] has stated that American vacuum-melted nickel-base alloys have some 15 to 35 deg. C. temperature advantage over air-melted alloys on the basis of 100-hour rupture life at 9 tons per sq. in. Significant improvements in high-temperature properties have been obtained for Nimocast 258 and Nimonic 105 (see Tables 4 and 5). Pronounced improvements in the rupture ductility of alloys in this class have been obtained by vacuum melting.

TABLE 3.—*Effect of Trace Additions on the Rupture Strength of Vacuum-melted Nickel-base Alloys* (*Ref.* 16).

Trace additions to base composition.*	Duration (hours) at 7 and 940 deg. C., tons per sq. in.	Elongation, per cent.
Nil	28	5
0.015 per cent. B	165	11
0.1 per cent. Zr	154	15
0.015 per cent B and 0.1 per cent. Zr	622	5

* 0.2 to 0.25 per cent. C, 11 to 12.5 per cent. Cr, 18 to 20 per cent. Co, 1.0 to 1.3 per cent. Ti, 5.0 to 5.4 per cent. Al, 5 to 6 per cent. Mo.

All the cast alloys under review, with the exception of Nimocast 258, are vacuum melted. Nimocast 713 is available in the air-melted form (713C) or, with slight change[7] in composition, in the vacuum-melted condition (713V). Air melting is preferably carried out in induction furnaces using non-acidic refractory linings (*e.g.*, magnesia or chrome-magnesite) and rapid rates of melting to minimize Ti and Al losses. Oxides that form during melting in air can be appreciably reduced by controlled calcium or calcium-silicide additions immediately prior to pouring. However, in order to ensure the highest-possible metallurgical quality, vacuum melting of this class of alloy is essential. A double vacuum-melting procedure is generally recommended. This involves the preparation of vacuum-melting stock in large vacuum-induction furnaces with subsequent melting in small vacuum-induction or controlled-atmosphere furnaces designed to receive one or more of the hot moulds normally used for investment casting. The wrought alloys listed in Table 1 are prepared by rolling, forging or extrusion, the latter method being favoured in this country for the very-high-strength alloys. G70 and Udimet 700 bar is prepared from vacuum-melted ingots.

Stress-to-rupture and Creep Properties

The main criterion for a rotor-blade alloy is the ability to withstand the maximum centrifugal

Alloys for Gas-turbine Rotor Blades

loading for the service life of the blading. As the latter varies with the engine, it is usual to determine the laboratory stress-to-rupture properties at 100, 300 and 1,000 hours respectively. For military engines the 100-hour rupture strength is of paramount importance. Available data are given in Table 6. Stress/temperature curves for the wrought alloys and representative cast alloys are given in Fig. 2. For the sake of clarity, some of the cast alloys have been omitted from these curves. The 100-hour stress-to-rupture properties of G64 and G67 are similar while those of Nimocast 258 (vacuum cast) and Nimocast 713V are intermediate to those of G64 and Udimet 700. The rupture strength of DCM alloy is higher at 870 deg. C. than that of the other cast alloys but it falls more markedly with temperature. With the exception of SM220 the densities of these alloys are similar and therefore, for the same centrifugal loading, the tensile stresses in service will be similar. The superiority of SM220 is reduced when comparisons are made on a specific strength basis (see Table 7). On this basis, EPK24 has the highest 100-hour rupture strength at 1,000 deg. C. of currently available cast and wrought nickel-base alloys.

From Fig. 2 it is evident that the vacuum-cast alloys are superior to the hot-worked alloys. Comparing the properties of EPK24 and Udimet 700 (or G70) the rupture-strength advantage of the cast alloy varies from 2 to 6 tons per sq. in. according to temperature, while at a stress level of 8 tons per sq. in. its temperature advantage is nearly 50 deg. C. The stress-to-rupture data at 300 and 1,000 hours is less comprehensive. Figures 3 and 4 indicate that the superiority of the cast alloys is maintained.

Tests at the National Gas Turbine Establishment (NGTE) showed that the rupture lives of the cast alloys Nimocast 258 (air-cast), G64, G67, G74 and Nicrotung (vacuum-cast) were generally within the range 30 to 50 hours compared to the 100 hour life obtained by the supplier at the same stress and temperature. This difference is not necessarily significant and, apart from heat-to-heat variations in properties, may be due to variations in the test conditions and in the size of the specimen or the casting from which the specimen was taken. The use of small diameter specimens *e.g.* less than 0.150 in., and a difference of 2 to 4 deg. C. in test temperature between customer and supplier could account for the reduction in rupture life. Few suppliers quote the test-specimen dimensions or the degree of temperature control used in stress-to-rupture tests; often it would be helpful to know whether the tests were carried out to a recommended BSS or ASTM specification.

The heat-treatment used to achieve the rupture-strength properties given in Table 6 may subsequently be altered if it transpires that the level of other required properties is inadequate. In achieving the desired balance of strength and ductility,

TABLE 4.—*Comparative Properties (in the As-cast Condition) of Air-cast and Vacuum cast Nimocast* 258 (*Ref.* 7).

Property.	Temp., deg. C.	Air-cast.	Vacuum-cast.
100 hour rupture stress, tons per sq. in.	870 980	17.8 7.0	18.5 7.5
100 hour* fatigue strength, tons per sq. in.	870 980	0 ± 18.5 0 ± 12.5	0 ± 18.6 0 ± 13.7
300 hour† fatigue strength, tons per sq in.	870 980	0 ± 17 0 ± 10.5	0 ± 17.5 0 ± 12.4

* 15 by 10^6 cycles, rotating bend fatigue.
† 45 by 10^6 cycles, rotating bend fatigue.

TABLE 5.—*Comparative Stress-rupture Properties of Nimocast* 105 *Prepared by Air-melting and Vacuum-melting* (*Ref.* 17).

Stress, tons per sq. in.	Temp., deg. C.	Air-melted.		Vacuum-melted.	
		Life, hr.	Per cent. El.	Life, hr.	Per cent. El.
7	940	80	10	120	25

TABLE 6.—100-*hour Stress-to-rupture Properties of Nickel-base Alloys.*

*Alloy.	Stress for 100 tons per sq. in hour rupture life at								Ref. No.
	870 deg. C.	900 deg. C.	926 deg. Co.	940 deg. C.	982 deg. C.	1,000 deg. C.	1,038 deg. C.	1,050 deg. C.	
Cast.									
Nimocast 258	18.5	—	—	—	7.5	—	—	—	7
Nimocast 713V	18.5	—	—	11.0	8.0	—	—	—	7
Inconel 717C	21.0	—	13.4	—	8.0	—	—	—	3
G64	—	15.2	—	—	—	7.6	—	5.2	6
G67	—	15.2	—	—	—	—	—	—	8
TRW 1800	22.8	—	16.0	—	10.7	—	7.1	—	9
Nicrotung	21.4	—	14.3	—	9.8	—	6.5	—	10
G74	—	—	—	—	—	—	—	—	11
DCM	25.0	—	14.0	—	9.0	—	5.6	—	12
IN 100 (EPK 24)	24.55	—	17.0	—	11.16	8.93 (1,010 deg. C.)	—	—	13
SM 220	—	—	—	—	13.0	—	8.2	7.5	11
Wrought.									
Nimonic 105	12.8	—	—	6.6	4.3	—	—	—	4
Nimonic 115	16.5	—	—	10.0	—	6.4	—	—	14
Udimet 700	18.3	—	12.0	—	7.1	—	—	—	15
G70	—	14.75	—	9.0 (950 deg. C.)	—	5.0	—	—	11

* Condition of heat-treatment as in Table 2, except for Nimocast 258 which was tested in vacuum-cast condition.

the full stress-to-rupture potential of the alloy may not be utilized.

Ductility at rupture is rarely given in published data. Child[16] has pointed out that the values for G64 and particularly G67 are higher than the cold-tensile ductility at fracture. In the early stages of alloy development, the degree of reproducibility of the rupture properties is not normally assessed. Gittus[17] has shown that for a vacuum-cast composition, similar to Nimocast 258, excellent reproducibility has been obtained, the standard deviations being 0.4 to 0.8 for the 100-hour rupture stress in the range 1,020 to 815 deg. C.

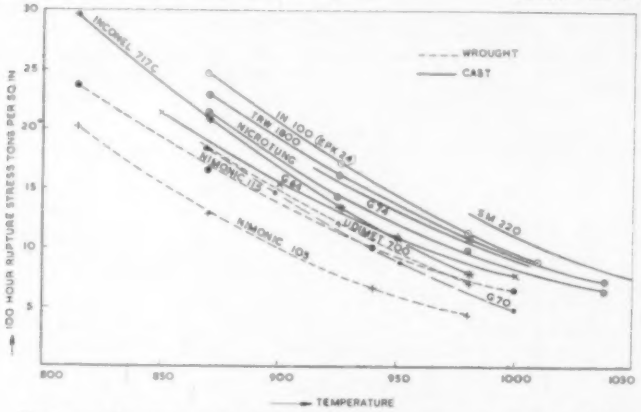


FIG. 2.—*100-hr. rupture-stress/temperature (deg. C.) curves for some typical cast and wrought gas-turbine alloys.*

Data on the stresses to give specified amounts of creep in 100 or 300 hours are considered less valuable by the blade-design engineer than the stress-to-rupture properties. This is because creep occurs to a significant extent only over a small region of the blade span and there is usually adequate blade tip clearance to accommodate it. Very little comparative creep data is available for the alloys in question. The stress to give 0.2 per cent. creep in 100-hours at 982 deg. C. is 4 tons per sq. in. for DCM alloy and 2 tons per sq. in. for Nimonic 105, while the stress to give 0.1 per cent. creep under the same conditions is 4 tons per sq. in. for Udimet 700.

Short-term Tensile Properties

The blade-design engineer attaches importance to the strength (particularly yield or proof strength) and ductility values obtained from short-time tensile tests. Published data for the compositions under review are given in Table 8. At 20 deg. C., the wrought and several of the cast alloys have 0.1 or 0.2 per cent. proof-stress values greater than 50 tons per sq. in., ultimate-strength values greater than 60 tons per sq. in. and ductilities (as determined by percentage elongation or reduction in area at fracture) ranging from 3.5 to 17 per cent. In the absence of information on the dimensions of the test specimen and the loading or strain rate used by the American suppliers, only the British data can be usefully compared. (Elongation at fracture varies with test specimen shape *e.g.* whether the specimen is circular or rectangular in cross section, and with the ratio of gauge length to cross-sectional area (A). Except for sheet materials, British suppliers use circular-section specimens of gauge length equal to $4\sqrt{A}$. The strain or loading rate is important since both yield strength and ductility can show appreciable increases with strain rate at temperatures where creep occurs.) The elongations at fracture of the cast alloys G64, Nimocast 258 and 713 (3.4 to 5.0 per cent.) are appreciably less at 20 deg. C. than those obtained on the wrought alloys Nimonic 105 and 115 (7 to 10 per cent.). In Fig. 5, comparison of the short-time tensile properties of G64 and Nimonic 115 (having near-similar stress-to-rupture properties) tested at reasonably similar loading rates show that the yield and ultimate strengths and the elongation at fracture of G64 are distinctly lower than those for Nimonic 115. However, the strength properties of G64 diminish less rapidly with increase in temperature above 700 deg. C. G64 and Nimonic 115 have minimum elongations at fracture of 1.0 per cent. (at 900 deg. C.) and 4.5 per cent. (at 870 deg. C.) respectively.

The exact amount of ductility necessary in a turbine blade is controversial. It has been stated[19] that American practice considers 8 to 10 per cent. desirable and 4 to 5 per cent. necessary. The successful use for aircraft gas-turbine rotor-blading of G64 (in production Proteus engines) and of the American GUY[17] alloy* (in experimental J33 engines) indicates that the limited tensile ductility of such alloys is not disadvantageous. This therefore raises the question as to whether the usual measurement of ductility has any engineering significance. Some ductility is necessary to allow adjustment to high localized stress concentrations *e.g.* at the blade-root fixing, and under conditions where impact damage may occur but it is possible that the elongation at the ultimate strength is of greater

* See Appendix I.

TABLE 7.—*Comparative Specific-rupture-strength Data.*

Alloy.	100 hour rupture stress tons per sq. in × G64 density / alloy density, at :—			
	900 deg. C.	950 deg. C.	1,000 deg. C.	1,050 deg. C.
G64	15.2	10.8	7.6	5.2
IN 100 (EPK. 24) ..	21.5	15	10.1	—
SM 220	—	—	9.0	6.2
Nimonic 115	14.0	9.4	6.5	—

significance than that at fracture. However, in many of these high-strength alloys, failure in tension occurs at the ultimate strength *i.e.* little or no "necking" is involved. In this respect, it might be helpful to the design engineer if the full stress/strain curve at each temperature were published by the supplier.

Mechanical Fatigue Properties

In the early development stages of a new blading alloy, the laboratory evaluation is often limited to stress/rupture and short-time tensile data. Only a small amount of fatigue data (see Table 9) is available for the compositions considered. It is apparent that the fatigue properties of three of the cast alloys compare favourably with Nimonic 105. In low-ductility alloys it is desirable to determine the

TABLE 8.—*Short-time Tensile Data on Nickel-base Alloys.*

Alloy.	Property.	Value at temperature, deg. C.										Strain or head rate.	Ref. No.
		20	650	700	800	816	870	900	950	982	1,000		
Cast.													
Nimocast 258 (air-cast and heat-treated)*	0.1 per cent. proof stress (tons per sq. in.)	49											7
	Ultimate tensile strength (t.s.i.)	55		54	52			40					
	Per cent. reduction in area	—											
	Per cent. elongation	3.4		3.5	3.5			3.5					
Nimocast 713 (aircast, no heat-treatment)	0.1 per cent. proof stress (t.s.i.)												
	U.T.S. (t.s.i.)	53			52			36			22		7
	Per cent. reduction in area	—											
	Per cent. elongation	5.0			6.0			8.0			17.0		
G64	0.1 per cent. proof stress (t.s.i.)	48	—	50.6	47	—	—	27.5	—	—	15.6	1 ton per sq. in. per min.	6
	0.2 per cent. proof stress (t.s.i.)	44.6	—	52.3	49.6	—	—	31.2	—	—	17.7		
	U.T.S. (t.s.i.)	54.5	—	57.5	55	—	—	41.2	—	—	22.5		
	Per cent. reduction in area												
	Per cent. elongation†	3.5	—	1.6	1.6	—	—	1.0	—	—	3.0		
G67	0.1 per cent. proof stress (t.s.i.)	50										Not quoted	8
	U.T.S. (t.s.i.)	59											
	Per cent. reduction in area												
	Per cent. elongation	1.6											
T.R.W. 1800	0.1 per cent. proof stress (t.s.i.)	56	54			51.5	43			28		Not quoted	9
	U.T.S. (t.s.i.)	62.5	62			58	51.5			33			
	Per cent. reduction in area	6	13			15	18			21			
	Per cent. elongation	6	11			8	6			8			
Nierotung	0.2 per cent. proof stress (t.s.i.)	54	49				35			22.5		Not quoted	10
	U.T.S. (t.s.i.)	59	53.8				40			30.7			
	Per cent. reduction in area	—	—				—			—			
	Per cent. elongation	5	10				4.5			6			
D.C.M.	0.2 per cent. proof stress (t.s.i.)	51.5	48	—	—	44.5	30	—	—	17	—	Not quoted	12
	U.T.S. (t.s.i.)	62.5	72.5	—	—	63.5	57	—	—	36	—		
	Per cent. reduction in area	9	8			12	10			32			
	Per cent. elongation	4	3	—	—	6	10	—	—	16	—		
IN 100 (EPK 24)	0.2 per cent. proof stress (t.s.i)	52	52.8			55	44			26		Not quoted	13
	U.T.S. (t.s.i.)	60.5	63			56	52.5			34			
	Per cent. reduction in area	—	—			—	—			—			
	Per cent. elongation	9	8			5	4.5			4.0			
Wrought.													
Nimonic 105	0.1 per cent. proof stress (t.s.i.)	51	—	48	31	—	—	17	—	—	9	0.4 t.s.i./min. up to U.T.S.: then strain rate of 0.3 in. per min.	4
	U.T.S. (t.s.i.)	64	—	64	46	—	—	26	—	—	11		
	Per cent. reduction in area	7	—	12	17	—	—	21	—	—	55		
	Per cent. elongation	7	—	10	16	—	—	20	—	—	46		
Nimonic 115	0.1 per cent. proof stress (t.s.i.)	50.4		52.8	40.8	—	—	—	—	—	11.6	0.4 t.s.i./min. up to U.T.S. then strain rate of 0.03 in. per min.	14
	U.T.S. (t.s.i.)	63.8		69.2	56.4	—	48.0‡	—	32.6‡	—	19.4		
	Per cent. reduction in area	9.6		9.2	1.8	—	4.8‡		8.0‡	—	13.0		
	Per cent. elongation	10		10	5.6	—	4.5‡	—	9.0‡	—	12.4		
Udimet 700	0.1 per cent. proof stress (t.s.i.)	62.5	54.5	—	—	—	40.5	—	—	19.2	—	Not quoted	15
	U.T.S. (t.s.i.)	90	80	—	—	—	45	—	—	23.2	—		
	Per cent. reduction in area	20	19.5	—	—	43	44	—	—	28	—		
	Per cent. elongation	17	16	—	—	33	33	—	—	28	—		

* 8 hr. at 1,080 deg. C., air cooled; 16 hr. 700 deg. C., air cooled; † based on $L = 4\sqrt{A}$; ‡ strain rate (cross-head movement) of 1/16 in. per min.

notch-fatigue characteristics since impact damage in service might conceivably accelerate mechanical-fatigue failure.

Thermal Fatigue Characteristics

Transient thermal stresses are produced from temperature gradients induced in the aerofoil section during acceleration and deceleration, particularly at start-up and shut-down. Engine tests[20] have shown that repeated normal starts, *i.e.*, repeated heating shocks caused thermal fatigue cracking at the leading edges of blades even when relatively little running under full-speed conditions was involved. Such cracks can propagate to fracture by creep or vibration fatigue so that the service life is considerably less than that expected from the laboratory stress-to-rupture tests. For a given engine transient and blade shape, the magnitude of the thermal gradients depends on the thermal properties of the blade alloy. The compositions under review have similar thermal properties; thermal conductivity is about 0.03 c.g.s. at 20 deg. C. increasing to about 0.06 c.g.s. at 900 deg. C., while the average coefficient of thermal expansion is 11 to 13 by 10^{-6} in. per in. per deg. C. over the temperature range 20 to 100 deg. C., and 16 to 18 by 10^{-6} in. per in. per deg. C. over 20 to 900 deg. C. Since failure results after a small number of cycles, plastic strain evidently occurs during each cycle and therefore thermal fatigue endurance is a function of the resistance of the material to repeated plastic deformation.

There is no accepted method of evaluating thermal fatigue behaviour in the laboratory. Different test techniques have resulted in different orders of merit for cast and wrought alloys of similar or dissimilar composition. However, they generally agree* in showing that thermal endurance falls markedly with rise in the upper temperature (T_2) of the cycle. Since rapid heating induces compressive plastic flow in the surface layers during the first few seconds followed by residual tensile strains when the blade is through-heated to T_2, it is reasonable to assume that the higher the temperature at which the yield point is maintained, the lower will be the plastic strain per cycle and, therefore, the longer the life. On the other hand the low ductility of these high strength alloys implies low resistance to cyclic plastic strain. Child[16], however, found that the high-strength/low-ductility alloy G64 had outstanding resistance to thermal fatigue at T_2 950 deg. C. compared to the hot-worked Nimonic alloys (see Table 10).

NGTE Test

The author and his colleagues at the NGTE developed[21, 22] a thermal fatigue test that involved the use of hot and cold fluidized beds as the heating and cooling media. For the small air mass flows required for fluidization, heat-transfer rates of the same order as those incurred at the turbine rotor blading were obtained. Alternate immersion of tapered-disc specimens, simulating the main dimensional features of a blade, was repeated until radial cracking was first observed at the disc periphery. The results of these tests, given in Table 11, show that G64 has higher thermal endurances at 920 and 1,020 deg. C. than the other test alloys. It would therefore appear that its low ductility is not detrimental to thermal fatigue resistance. The limited data on Nicrotung and Nimocast 258 indicates that vacuum-cast alloys have greater thermal endurances than air or inert-atmosphere cast specimens, as would be expected from the increase in ductility resulting from the use of vacuum melting. Since failure in all these alloys is intergranular,

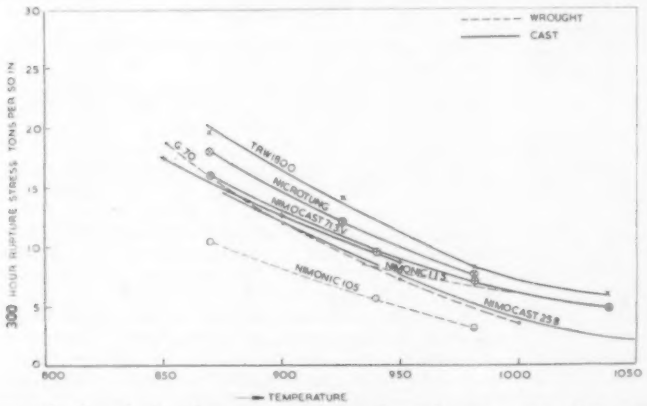
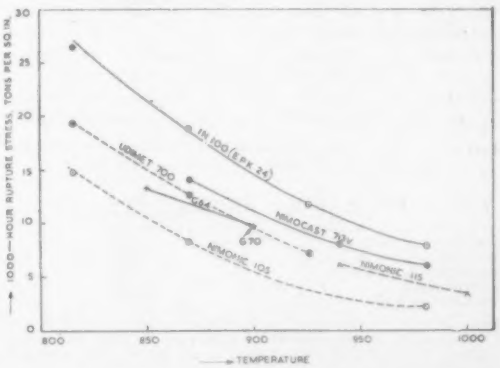


FIG. 3.—300-*hr. rupture-stress/temperature (deg. C.) curves for cast and wrought nickel-base alloys.*

FIG. 4.—1,000-*hr. rupture-stress/temperature curves for cast and wrought nickel-base alloys (temperatures in centigrade scale).*



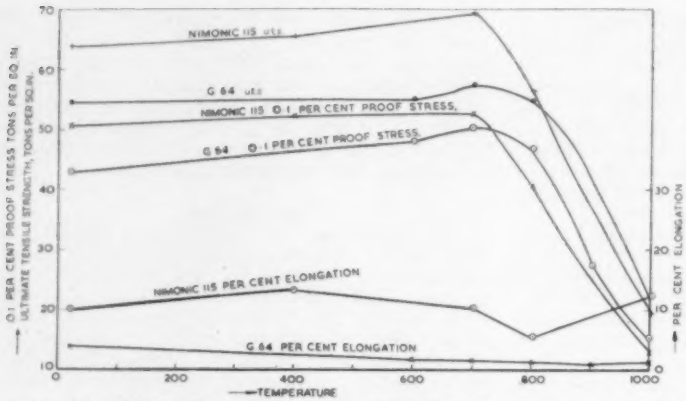


FIG. 5.—*Variations with temperature (deg. C.) of the short-time tensile properties of G64 and Nimonic 115 alloys.*

and is initiated at the surface, the properties of the grain boundary and its resistance to embrittlement in service by precipitation of brittle phases or by intergranular oxidation may be of paramount importance.

TABLE 9.—*Mechanical-fatigue Test Data.*

Alloy.	Fatigue stress,* tons per sq. in.		Cycles to failure.	Time (hr.).	Ref. No.
	870 deg. C.	982 deg. C.			
Nimocast 258 (air-cast)	±17	±10.5	45×10^3	300	7
Nimocast 258 (vacuum-cast)	±17.5	±12.4	45×10^3	300	7
G64	±18	—	100×10^3	Not given	6
Nimonic 105 ..	±17.6	± 8.3	45×10^3	300	4
G70	±14.0	—	100×10^3	330	11

* Rotating bend.

Mechanical Shock Resistance

Experience with ceramics and cermets indicates that mechanical shock or impact resistance diminishes as ductility approaches low or negligible values. It is reasonable therefore to suppose that high-strength, low-ductility alloys may have insufficient resistance to withstand the impact of "foreign bodies" *e.g.*, stones, fragments of flame tubes that occasionally pass through the engine. At one time, it was considered that the impact strength of X40 was virtually the minimum that could be accepted. Engine tests[18] on GUY alloy indicated that its resistance to impact was satisfactory despite its low ductility. Obviously, the thickness of the blade edges as well as the nature of the impacting material are also important. No laboratory data is available on the resistance to impact of the alloys under review, and no standard test has been devised. Both low-velocity (Izod or Charpy type) and high-velocity (ballistic type) tests have been used. It is likely that the impact strength characteristics of these alloys will require much more consideration in the future.

TABLE 10.—*Comparison of Thermal-fatigue Performances of Wrought and Cast Alloys (Ref. 16).*

Material.	No. of cycles to produce cracking* at 950 deg. C.
Wrought Nimonic 80A	530
Wrought Nimonic 90	160
Wrought Nimonic 95	210
Cast Vitallium	220
Vacuum-cast G64	8,000+

* Unstressed wedge specimens, 3½-in. long by 1½-in. wide with 0.020-in. thick trailing edge, heated to 950 deg. C. with oxygen/gas blowpipe for 1 min. and cooled in air for 1 min.

Corrosion Resistance

The resistance to oxidation of the Nimonic and Nimocast alloys is excellent up to at least 1,100 deg. C., as indicated by the steady state oxidation test data in Table 12. Very little data is available on the other alloys listed in Table 1. At 982 deg. C., the depth of intergranular attack on TRW 1800 after 400 hours heating in air is less than 0.001 in. The brochure on IN 100 (EPK 24) suggests that for service at 1,038 deg. C., aluminising is necessary. Under certain service conditions accelerated corrosion of turbine blading by sulphur compounds has occurred. An increase in the chromium content of the alloy to about 15 per cent. can reduce this attack appreciably, but in the case of G64 it has been found[5] preferable to aluminise the blades, thereby providing not only high resistance to sulphate attack but also to oxidation and to thermal fatigue.

Castability and Grain-size Control

Although improved castability is a natural consequence of vacuum melting, it does not follow that these compositions possessing high hot strengths are excellent casting alloys. Factors such as the carbon, boron and zirconium contents, and the solidus/liquidus range may have greater influence on castability. As for most of the properties considered, there is no standard test for acceptance. Castability is usually assessed according to the ability of the foundry to make individual blade designs with the best possible metallurgical quality at the lowest scrap rate. Grain-size control is essential. In cast alloys, it is determined solely by the casting conditions and mould design, but in wrought alloys, control is effected by cold work and heat-treatment. The resulting changes in properties are associated with, rather than due to, grain-size alterations. In these complex alloys it is rarely possible to vary grain size without solution or precipitation of one or more secondary phases that may strongly influence mechanical properties.

Rupture strength generally increases with grain size while tensile ductility, particularly at room

TABLE 11.—*Comparative NGTE Thermal-fatigue Test* Data on High-temperature Alloys.*

Alloy.	Condition.	T_2, deg. C	Number of cycles, *Nf*, to first observed crack on specimen, No.			*Nf* (mean).
			1	2	3	
Nicrotung ..	Vacuum-melted stock	920	8	6	—	7
		1,020	2	3		2.5
	Vacuum melt, argon-cast	920	17	22	—	19.5
		1,020	7	9		8
	Argon melt and argon-cast	920	7	12	7	9
Nimocast 258	Vacuum cast ..	920	85	95	—	90
		1,020	18	18	—	18
	Air cast ..	920	28	38	—	33
		1,020	5	9	—	7
G64 ..	Vacuum cast ..	920	245	375	385	335
		970	183	—	—	183
		1,020	45	43	43	44
G67 ..	Vacuum cast ..	920	205	245	—	225
		970	72	112	140	107
		1,020	25	17	23	22
Nimonic 105	Forged and heat-treated	920	145	145	155	148
		1,020	37	37	30	35

* Alternate rapid heating and rapid cooling in hot and cold fluidized beds at T_2 and 20 deg. C. respectively, using a tapered-disc specimen (o.d. 1.625 in., maximum thickness 0.275 in., peripheral radius 0.010 in.).

temperature, is often reduced. For maximum resistance to mechanical and thermal fatigue, there is probably an optimum grain size which may vary with temperature and composition. There is some evidence that coarse-grained structures adversely affect thermal-fatigue behaviour. Reverse-bend fatigue tests carried out by Toolin[22] on notched and unnotched specimens of the air-cast alloy, Refractaloy 26 (see Appendix 1), indicated that below about 700 deg. C., coarse-grained structures have lower fatigue strengths at $\times 10^5$ cycles than fine-grained, but are superior above 800 deg. C. For maximum impact strength, fine-grained structures are probably preferred and it is possible that blades may be required with a controlled fine-grained structure at the leading and trailing edges and relatively coarse-grained interior.

Future Developments

It is generally agreed that an increase in temperature of some 50 to 100 deg. C. is the most that can be expected from conventional alloys. Its achievement for wrought alloys will present difficult production and fabrication problems. The wider use of vacuum melting will encourage research into the usefulness of minor alloying additions to both nickel and cobalt-base alloys. The current tendency to use comparatively-high tungsten contents may not yield alloys of significantly greater specific rupture strength and has the disadvantage of increasing the engine weight at a time when considerable efforts are being made to reduce the weight of other components. Air melting for producing high-hot-strength alloys has not necessarily been discarded. A recently-developed low-carbon nickel-base alloy[24], EPE10 containing about 6 per cent. niobium (see Appendix 1) has excellent air-casting characteristics with complete freedom from oxide inclusions. Although its 100 hour-rupture strength at 870 deg. C. (8.0 tons per sq. in.) and 940 deg. C. (5.5 tons per sq. in.) is not as high as the nickel-base alloys considered in this review, the hardening principle (by a niobium-nickel compound) is novel, and this composition may be the forerunner of stronger

TABLE 12.—*Oxidation Resistance of Three Nickel-base Alloys.*

Alloy.	Wt. loss (mg. per cm.^{2}) after 100 hours at				Reference No.
	800 deg. C.	900 deg. C.	1,000 deg. C.	1,100 deg. C.	
N 105	0.11	0.49	1.43	6.41	4
Nimocast 258 ..	0.65	1.95	2.72	9.80	7
Nimocast 713c ..	0.67	(1.5)	2.33	3.30	7

alloys. Alternatively, current researches into the usefulness of dispersion-hardened alloys prepared by sintering of 80 per cent. Ni/20 per cent. Cr type alloys containing controlled additions of Al_2O_3, ThO_2 or CeO may give promising high temperature, high-strength properties. Evidently the ingenuity of the research metallurgist in this field is not yet defeated by the magnitude of the problem.

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(*References continued on page* 302).

APPENDIX I.—*Nominal or Typical Compositions (per cent.) of High-temperature Alloys.*

Alloy.	C	Cr	Co	Ni	Al	Ti	Mo	W	Nb	Fe	B	Ref. No.
F 484	0.4	25	Bal.	5	—	—	4	4	4	2	1	3
GUY	0.1 max.	12	—	Bal.	6.0	—	6	—	2	4.5	0.5	18
Refractaloy 26	0.05	18	20	Bal.	0.2	2.8	3	—	—	18	—	23
EPE 10	0.05 max.	20	—	Bal.	—	—	6	2.5	6.0	4 max.	—	24

Alloys for Gas-turbine Rotor Blades

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Addiction to Fumes

By "Barrister-at-Law"

The case of Jones *versus* Lionite Specialists (Cardiff), Limited raises a very curious point. Apparently, persons whose employment exposes them to the inhalation of sometimes dangerous vapours, such as trichlorethylene, are liable to acquire a craving and an addiction for the vapour. They will deliberately inhale it or even drink the liquid formed from it.

In the above case, the workman had unfortunately by the nature of his work, become addicted to trichlorethylene vapour. He had been seen on more than one occasion standing in a tank and deliberately inhaling it. Six months before his death as the result of such inhalations, he had become a hopeless addict and virtually everybody around knew of his affliction. He had been warned and admonished and even threatened with dismissal by his superior, who at all material times was fully aware of the position. However, nothing was done by the superior to cope effectively with the very perilous situation in which the unfortunate workman was. Thus the superior could have consulted the manufacturers of the vapour-forming material and asked them for their advice; again he may have approached the workman's family and his doctor or he may have reported the matter to the factory inspector. He failed to do any of these things. In the view of the Court, the superior had failed to take any reasonable steps to prevent the continuance of the exposure of the workman to these very obvious dangers which were besetting him in the course of his employment.

Accordingly the defendants, the employers of the deceased workman, were held liable for the *negligence* of the factory superior towards the deceased. As however the deceased by his failure, at the beginning, to exercise normal control of himself, and by his deliberate disobedience of his employer's orders and instructions, had brought this addiction on himself and his ultimate death, he was to be regarded in the opinion of the Court as being guilty to some extent—25 per cent.—of contributory negligence.

Silicates in the Foundry*

The most spectacular use of silicates within the last few years has been in the CO_2 foundry process. Earlier attempts to incorporate silicate binders in conventional foundry moulds and cores had met with limited success, but the advent of the CO_2 process brought these materials into real prominence. The system, which it is contended has saved foundries millions of pounds, produces cores and moulds which are completely ready for use immediately after processing, no stoving or curing period being required. The binding effect is obtained by the addition of sodium silicate to the moulding sand, hardening being brought about by blowing carbon dioxide through the mix immediately after it is consolidated around the pattern. The idea is that each grain of sand is surrounded by a thin film of silica, the initial reaction being the formation of silica gel on the surfaces of the silicate, which imparts a certain degree of strength to the mass. The unreacted silicate, on losing water, then forms a glassy silicate which binds the whole mass together with great strength. Not only is much time saved by the process, with a reduction in space required to set moulds aside for drying or other methods of curing, but the increased strength reduces the need for reinforcement of moulds and cores, saving further cost and simplifying design.

Other Processes

Less well known is the "Antioch" process, in which sodium silicate is used to bind a gypsum mould-material, which is prepared in the form of a slurry. Although stoving is required, so that the saving in time is not significant, the workability of the slurry is claimed to permit intimate reproduction of very complex patterns and to produce an excellent surface finish. In the lost-wax process now widely used in the production of complex parts—such as turbine blades—from highly refractory metals, the binding agents in the primary and secondary investment round the wax pattern are frequently based on silicate solutions, the latest development being a range of sodium-potassium and isopropyl silicates which it is claimed can produce very fine and consistent results.

In shell moulding, for the production of intricate and finely finished castings, the use of sodium silicate as a binder to replace the more expensive resins is achieving some popularity. In this case, the mix is blown on to the surface of a heated pattern, and sets to produce surface finish and integrity believed to be at least equal to that achieved with resin shells.

Other applications of silicates in foundries include impregnating porous castings which are otherwise mechanically sound and thermal protection and lubrication of dies by applying silicate-based dressings.

* Based on information supplied by Joseph Crosfield and Sons, Limited, on the occasion of the opening of laboratory and research extensions.

News in Brief

WORK ON A NEW METALLURGY BUILDING at Sheffield University, is to start, together with an arts building, in December. The two projects together will cost £1,500,000.

THE FIRST Sheffield and district sales office of George Kent, Limited, instrument makers, Luton, was opened on August 24, Mr. L. Bartlett, sales director, performing the opening ceremony.

THE BLYTH DEPOT of Singlehurst Equipment, Limited, has been transferred to 29, Carlton Street, Blyth, Northumberland. The depot remains under the management of Mr. Angus Galloway.

WILSON & LONGBOTTOM, LIMITED, textile engineers, Barnsley, report that work on a new design research building is ahead of schedule and the project should be completed by the middle of November.

CROFTS (ENGINEERS), LIMITED, power transmission engineers, Bradford, have extended their stockholding service to the London branch, at 36/42, Tanner Street, Bermondsey, London, S.E.1 ('phone: HOP 7751/4).

THE DERBY FIRM of Aiton & Company, Limited, has received orders for power-station equipment from Malaya and Cairo totalling £300,000. Both orders concern piping for new power-plants in the two countries.

THE ARGENTINE MINISTRY OF ECONOMY has approved a proposal by the Metropolitan-Cammell Carriage & Wagon Company, Limited, of Britain, to invest £200,000 in a plant for the production and repair of railway material.

DURING THE PAST TWO MONTHS, a productivity team on welding from the National Productivity Council of India has been visiting Japan, the USA and West Germany; at the invitation of the Institute of Welding it visited Great Britain the week before last.

BENJAMIN ELECTRIC, LIMITED, of London, opened their new Scottish offices at 259, St. Vincent Street, Glasgow, C.2, on September 5. The recently-appointed area manager for Scotland and Northern Ireland, Mr. J. M. Anderson, will be centred at the Glasgow office.

THE HEADQUARTERS of the Department of Scientific and Industrial Research are removing from Charles House, Regent Street, London, S.W.1, to State House, High Holborn, London, W.C.1 ('phone: CHANCERY 1262), and in future all correspondence should be addressed there.

MORE THAN £15,000 from the works bonus scheme was shared by about 1,800 workers employed by Peglers, Limited, brassfounders, Doncaster, at the start of their St. Leger week holiday. Members of the staff have their bonus in June, under a separate scheme.

E. BOYDELL & COMPANY, LIMITED, of Manchester, manufacturers of the Muir-Hill range of dumpers, loaders and shunters, have appointed H. W. Lees & Son, Linden, Kill Lane, Foxrock, Co. Dublin, as their sole distributors in Eire with effect from September 1.

ORDERS FOR THREE CARGO MOTORSHIPS to the value of more than £3,000,000 have been placed with the Greenock Dockyard Company, Limited, by the British & Commonwealth Shipping Company, Limited. The ships, of 9,300 tons gross each, will be 470-ft. long with engines of 8,500 b.h.p.

THE FOLLOWING PARTS of the Report on the Census of Production for 1958 may be obtained from H.M. Stationery Office at York House, Kingsway, London, W.C.2:—Part 41 Non-ferrous Metals; price 3s. (postage 4d.); and Part 62 Shipbuilding and Marine Engineering; price 2s. (postage 2d.).

BLACK & DECKER, LIMITED, manufacturers of electrical power tools, has acquired a leading Italian company in this field, Imobilaire Civatese S.p.A., and its manufacturing subsidiary, Star Utensili Electrici S.p.A. This move has been taken, states Black & Decker, to penetrate further into the European market.

CONSIDERABLE EXTENSIONS are planned by the Emco Brass Manufacturing Company, Limited, at Westwood, Kent. The main factory building is to be enlarged and two new workshops erected. The welding department is to be removed to a new site and enlarged and a considerable amount of new equipment will be installed.

MITCHELL GLASS COMPANY, LIMITED, engineers, Victoria Works, Raglan Street, Bradford, recently despatched from Bradford an £8,000 piece of glass manufacturing machinery on a 1,000-mile journey by lorry across Europe to Czechoslovakia, where it will be on show at the Brno Trade Fair, near Prague, for 10 days from September 10.

FIRE WHICH BROKE OUT in a stack of wood patterns in the yard at the works of the Wombwell Foundry & Engineering Company, Limited, on August 29 caused damage estimated at about £500. Fire brigades from Hoyland, Wombwell and Wath-on-Dearne prevented the flames spreading to adjoining buildings. It was stated that production would not be affected.

VILLIERS ENGINEERING COMPANY, LIMITED, Wolverhampton, are to supply all future engines for the Francis-Barnett and James motor-cycles and scooters, by arrangement with Associated Motor Cycles, Limited, of Woolwich, who have announced that they are ceasing immediately the manufacture of two-stroke engines in order to make provision for more diversified activities within the group.

BY THE END OF THIS YEAR, exports by Tangyes, Limited, Smethwick, should be well over the target figure said managing director, Mr. C. G. Tangye, speaking at a two-day symposium sponsored by the company. Despite fierce competition from overseas, the company's home and export sales for hydraulic equipment was showing an increase of over 50 per cent. compared with the same period last year.

TAYLOR'S BELL FOUNDRY, LIMITED, Loughborough, have provided the two tenor bells, each weighing between three and four cwt., which arrived for hanging at Gedling Parish Church, Nottinghamshire, on August 29. The bells have been given by a Gedling couple, Major and Mrs. Horace Clough, in memory of their parents. The existing four bells were recast in 1902 and the new bells will be hung above them.

THE COMBUSTION ENGINEERING ASSOCIATION is organizing a conference at the Northern Exhibition of Fuel and Power for Industry, Queens Hall, Sovereign Street, Leeds, on Thursday, October 19. The subjects to be covered are grit and dust from small boiler plants and the seventh Progress Survey of the National Industrial Fuel Efficiency Service. Full details are available from the director of the Association, 70, Jermyn Street, London, S.W.1.

AT THE works of John Robson, Limited, diesel-engine makers, Shipley, last week, an engine flywheel weighing about five tons shattered into pieces. One of the largest pieces ploughed its way the length of a suite of six offices. Another piece weighing half a ton smashed the guttering of a nearby terrace house and embedded itself in the road two streets

News in Brief

away. One man was injured—a passer-by, Mr. Arthur Hepworth, who was on his way to work.

A PRIVATE HELIPORT is to be established at the newly-opened Maltby branch of Hack Saws, Limited, Sheffield. It is to be built inside the factory grounds only two minutes' walk from the main offices. The heliport will enable flights to be made direct from the works to industrial centres such as London and Birmingham. For the time being single-engined helicopters will be used and the journey from Maltby to London will take approximately an hour-and-a-half.

SOME ROTHERHAM STEELMEN flew out to Durgapur, India, over the weekend of September 2 to take temporary jobs in the new steelworks, being built by a British consortium of steel firms. They will stay about a year to assist the smooth running of the new plant and then return to their work in this country. Four of the men are from the Steel, Peech & Tozer branch of the United Steel Companies, Limited, and two from a susbidiary company, Owen & Dyson, Limited.

A SPECIAL APPRENTICE-SIGNING CEREMONY was held in the staff dining room of Steel, Peech & Tozer, Rotherham, on August 31, when young men chosen from 121 candidates interviewed signed an agreement. By tradition each new apprentice was allowed to keep the pen with which he signed. Mr. Moore, chief engineer, asked the parents present to give their sons some positive encouragement to pursue their studies and to resist the many possible distractions, such as television, cinema, theatre and sport.

THE RIPLEY (DERBYSHIRE) FAMILY FIRM of G. C. Ogle & Sons, Limited, agricultural-machinery manufacturers, whose foundry closed down a year ago, throwing 10 men out of work, is to be wound up completely. Just after the last war the firm employed 200 people, but in recent years there have been staff cuts and only 30 are affected by the close-down. "Automation by our competitors has squeezed us out of the market," according to the firm's secretary, Mr. F. G. Ogle, a grandson of the founder.

BRITAIN'S ENTRY INTO THE COMMON MARKET is strongly supported by Mr. Robert Asquith, head of the Asquith Machine Tool Corporation, Limited, in the latest issue of *Production News*, the firm's quarterly journal. He points out that the Machine Tool Trades Association urged joining EEC as far back as 1957, and says that "everything has tended to strengthen our conviction that on balance, nothing but good so far as the machine-tool industry is concerned can result from Great Britain joining the Common Market."

INTERNATIONAL SYSTEMS CONTROL, LIMITED, of Wembley, announce that Thompson Ramo Wooldridge Inc. of Los Angeles (which, with the General Electric Company, Limited, of England, is jointly interested in I.S.C., Limited) has received an order from the Great Lakes steel division of the National Steel Corporation for a computer system to control the extensive basic-oxygen steel-furnace plant at Detroit. The computer will take into account all the characteristics of the raw material and the furnace, as well as the specification for the end product.

THE DU PONT ORGANIZATION in the USA has bought from Australia the American rights for the use of new chromium alloys that are expected to increase the efficiency of aircraft turbine engines. The new alloys have been developed after several years of research in the Department of Supply's Aeronautical Research Laboratories and the Defence Standard's Laboratories. Supply Minister Hulme announcing the signing of the agreement said the Du Pont organization had paid a substantial sum for the rights, and would now start a programme to produce the alloys commercially.

CHAMBERS BROS., LIMITED, ganister manufacturers, Stoke Street, Sheffield, despatched 750 tons of refractories lining material to North Sweden on August 29. The consignment is for use by a Swedish steelmaking firm only a few miles from the Arctic Circle. The Swedish firm take their supply annually in bulk from the Sheffield manufacturers. The contract began several years ago and since then has been the largest annual export contract of Chamber Bros. The first stage of the journey was done by 10 barges which made a 16-hour trip to Goole and the material was there transferred to a Dutch coaster, destined for Lulea, in the Gulf of Bothnia.

Mr. JAMES PRIESTMAN, deputy managing director of Priestman Bros., Limited, engineers, Hedon Road, Hull, has returned from a month's tour of South America in which he covered 15,000 miles. Orders totalling £100,000 are hoped for as a result in the entirely new market of Brazil. The country has already imported one of the firm's excavators, three more units have been ordered, and provisional orders made for five more. It is estimated that Mr. Priestman's tour has directly resulted in the firm securing orders for £250,000 in both new and established markets against strong competition from other countries including America, Japan and Germany.

THE YORKSHIRE REGION of the Engineering Industries Association will hold its second annual exhibition of members' products in Carlton Barracks, Claypit Lane, Leeds, on October 12 to 13. The exhibition will be opened by the Lord Mayor of Leeds (Ald. P. A. Woodward). Yorkshire was the first region outside London to hold an exhibition of members' products and the decision to transfer it this year to Carlton Barracks from the Queens Hotel means that there will be no limitation as to weight or size of exhibit. According to Mr. Ernest Barrett (Henry Barrett & Sons, Limited, Bradford), chairman of the Yorkshire region, there will be more than 60 stands.

ENGLISH STEEL CORPORATION, LIMITED, are holding a series of six "open nights" at their three Sheffield works. They were inaugurated by Viscount Knollys, chairman of the firm, who with his wife made a tour of the works on August 21, before 700 employees and their families came to the first open night. In addition to the various stages of steel manufacture visitors are shown a model of a Massey hammer made by the apprentices and shown recently in London. At the last series of open nights more than 7,500 people visited the works. This series is expected to be attended by nearly 10,000 with the additional attractions of the Tinsley Park scheme and the new 80-ton electric-arc furnace.

A CONFERENCE on industrial education held at Sheffield University on August 31 set up a committee to arrange lectures, discussions and seminars on a regular basis for Sheffield industrial and business men. The conference, attended by representatives of Sheffield firms, the Junior Chamber of Commerce and the Sheffield Institute of Personnel Management, was held to provide local firms with an opportunity of indicating the kind of courses likely to be of most use to them. Members of the committee include Dr. O. Gilbert, United Steel Companies, Limited; Mr. G. Page, Jessop-Saville, Limited, and Mr. K. H. Lewis, English Steel Corporation, Limited. Professor D. C. Hague, Newton Chambers Professor of Applied Economics at Sheffield University, is also being asked to join the committee.

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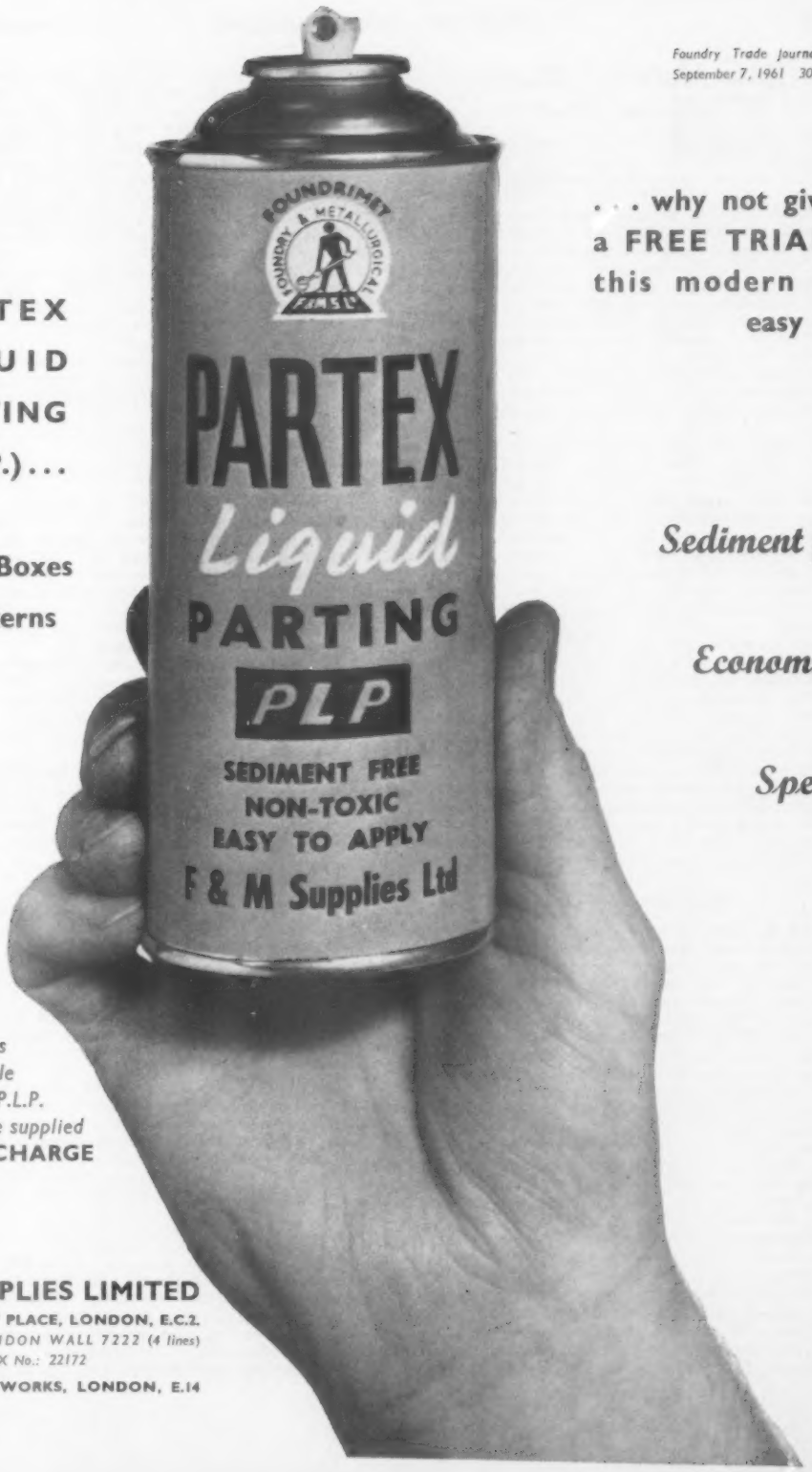

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Raw Material Markets

Iron and Steel

Most ironfoundries could undertake more work, though the engineering and speciality foundries continue to supply substantial quantities of high-duty castings. Although they are the most favourably employed, some of them are now having difficulty in maintaining a five-day working week, due to a falling off in demand. Regular quantities of castings are being called for by the trades for which they cater but in many instances the tonnages specified are much lower than those previously scheduled.

Most of the light foundries are striving to obtain more business, particularly those connected with the domestic equipment trades. Overall demands from these trades show little improvement, but some of these foundries continue to improve their outputs by supplying castings outside their normal production to other trades.

All grades of pig-iron are plentiful and demands consist mainly of those tonnages which are needed for current consumption needs and a working stock. The present easy supply position does not warrant forward buying as deliveries can be secured promptly. The steelworks continue to take up substantial tonnages of basic pig-iron, but there are tonnages to spare and some furnaces are working below capacity levels. The ironfoundries are also well provided with pig-iron and most producers could step up deliveries if required to do so.

Most foundries are able to cover for their requirements of scrap, apart from special grades, and there is no difficulty in obtaining supplies of foundry coke, ganister, limestone, and firebricks.

Most of the re-rollers are in need of more work. There is little if any improvement in the demands for small bars, light sections, and strip. Home demands are on a reduced scale and export business is difficult to obtain against the lower prices quoted by makers abroad. Plentiful supplies of both mild steel and carbon quality semis are available from home steelworks, and while alloy steels are more freely obtainable delivery dates are on an extended basis.

Non-ferrous Metals

Since the three months' metal price of tin declined in December and January to a level in the £780 range, its rise has been almost meteoric. Speculators have been buying tin, dealers have shown considerable reluctance to sell, and there was a good consumer-demand for the metal in Singapore. It was also noted that offers of tin from China had dwindled recently, a trend which culminated in unconfirmed reports that for the present the Chinese Government had decided to stop selling tin altogether.

Under these influences prices on the London Metal Exchange have bounded ahead and, at its best, three months' metal touched £997 a ton, its highest level since the early months of the Korean war. Meanwhile the statistical strength of tin has continued to manifest itself. Stocks held in LME warehouses are still falling while the ease with which the US General Services Administration cleared its latest release of tin held from the formerly State-owned Texas smelter hinted at the existence of a considerable unsatisfied demand for the metal.

In spite of renewed firmness on the Singapore market, trading in London is now quieter and feeling on the Continent and in the US has served as a subduing influence. There was a sharp fall in price at the beginning of the week, when cash metal closed at £941 and three months' metal dropped to £953.

Copper has been fairly active, slight increases being noted in both spot and three months' prices. The still unresolved labour disputes in the Chilean copper industry, with a loss of production already estimated at 36,000 tons, has become a significant factor in the market and those normally relying on Chilean shipments are believed to be seeking supplies elsewhere. There has been a further small reduction in LME warehouse stocks.

Lead is fairly quiet with buying and selling evenly matched and prices are generally well maintained. The fall in LME warehouse stocks last week, though modest, helped to impart steadiness in the face of a quiet consumer demand.

There has been no significant change in zinc where, again, the modest reduction in warehouse stocks, has proved a helpful factor in the absence of any worthwhile buying interest.

Ergonomics in Industry

Ergonomics, the study of man in relation to his working environment, was now widely recognized in industry for its importance in the rational design of machinery and in the control of the immediate climatic environment in which tasks needed to be carried out, said Sir Wilfred Le Gros Clark in his presidential address to the annual meeting of the British Association for the Advancement of Science at Norwich last week.

Sir Wilfred maintained that international co-operation was characteristic of science. The Ergonomics Research Society, because of the importance of its work in so many fields of economic importance, attracted membership from individual scientists all over the world.

The atomic physicist, Sir John Cockcroft, FRS, was elected president of the Association for 1961-62. After the war, as director of research at Harwell, Sir John was responsible for much of the fundamental work of Britain's atomic energy programme.

Mather & Platt in Australia

At a purchase price of just under £A1,000,000, Mather & Platt, Limited, electrical, textile, and hydraulic engineers, etc., of Manchester, has acquired from Brambles Industries, Limited, the Australian industrial group, all the capital of Kelly & Lewis (Pty), one of the leading hydraulic engineering organizations in the Southern Hemisphere.

Mather & Platt's existing sales organization in Australia will be amalgamated with Kelly & Lewis, which has £A2,000,000 worth of orders on its books. By acquiring one of its leading competitors, it is considered that Mather & Platt should now be established as the largest pump manufacturer in Australia.

Mr. William L. Mather, chairman of Mather & Platt, will join the board of the Australian company.

IT IS REGRETTED that the paragraph reviewing a catalogue on "Castable Refractories" (JOURNAL, August 24, p. 242) is misleading. It should have stated that the booklet gives the properties and method of application of a number of proprietary brands of bagged refractories, etc. Apologies are made to the firm—Silbond Refractories, Limited—and to readers.

Electrical Aids in Industry—Data Sheet **19**

Factory Heating—2

It is impossible in this Data Sheet to describe in detail every type of electric heater on the market, but a representative selection is dealt with below. Each type of building presents its own problem, and the best plan is to seek advice from your Electricity Board, who will be pleased to help.

'OFF PEAK' ELECTRIC HEATING

Because the 'off peak' load makes use of generating and distributing equipment when it would otherwise be idle or underloaded, the Electricity Boards offer cheap 'off peak' tariffs. Three types of 'off peak' heating systems are available, namely:

(a) Hot water storage heating: This consists of a conventional hot water radiator or panel heating system through which hot water from a large storage vessel is circulated. The water in the storage vessel is heated electrically during the 'off peak', low tariff hours and is circulated when required through the radiators or panels.

(b) Block storage heaters: These heaters consist essentially of a number of firebrick blocks which are heated up during the 'off peak' hours by means of suitable electric heating elements. The storage heaters are clad with a layer of suitable heat-insulating material and are housed in a sheet metal casing, the design being such that the stored heat is gradually dissipated throughout the day by means of radiation and convection. These heaters can easily be installed in existing buildings.

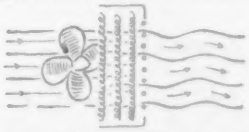
(c) Floor warming: In an 'off peak' floor warming installation, electric heating

Plan view of room *Isometric view of heating cable*

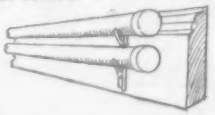
cables or ducts housing withdrawable cables are embedded in the concrete floor of the building. The cables are switched on and the floor is heated up during the 'off peak' hours, and the mass of concrete and screed of the finished floor has sufficient thermal storage capacity to heat the building during the period when current is not available. This method is only applicable to new buildings.

DIRECT ELECTRIC HEATING

(a) Unit heaters: These consist of a bank of electric heating elements fixed in a casing on which is mounted a fan which draws or blows air over the heating elements and discharges it in the required direction. Such units are mounted on the walls or stanchions or hung from the roof members in appropriate positions throughout the works.



(b) Infra-red heaters: These consist of heating elements usually of the sheathed metal or silica tube type mounted in a polished reflector. They operate at temperatures from 700° to 900°C, and give off the greater part of their heat output by radiation. They are mounted overhead and are particularly useful for providing local areas of comfort in spaces not otherwise heated.



(c) Tubular heaters: These take the form of tubes approximately 2" in diameter containing an electric heating element and are available in lengths from 2 to 17 feet. The normal loading is 60 watts per foot run and the surface temperature is from 180° to 200°F. They are usually placed round the walls at skirting level, but also can be used at high level in order to prevent downdraughts.

For further information get in touch with your Electricity Board or write direct to the Electrical Development Association, 2 Savoy Hill, London, W.C.2. Telephone: TEMple Bar 9434.

Excellent reference books on the industrial and commercial uses of electricity and reprints of articles and papers are available.

E.D.A. have available on free loan in the U.K. a series of films on the industrial uses of electricity. Film and Book catalogues and Publications List sent on request.

CUT HERE

Current Prices of Iron, Steel, and Non-ferrous Metals

(Basis prices, delivered unless otherwise stated. Prices following side headings marked* are subject to an increase of 1 per cent. under Iron and Steel Board Price Determination, 1961, No. 2.)

September 6, 1961

PIG-IRON

* **Foundry Iron.**—No. 3 IRON, CLASS 2, 10-ton lots or over, Middlesbrough, £21 17s. 0d.; Birmingham, £21 9s. 3d.

* **Low-phosphorus Iron.**—Over 0.10 to 0.40 per cent. P, 10-ton lots or over, £23 5s. 0d., delivered Birmingham; £23 10s. 0d., delivered Grangemouth.

Cylinder and Refined Irons.—North Zone, £25 6s. 6d.; South Zone, £25 9s. 0d.

Refined Malleable.—P, 0.10 per cent. max.; North Zone, £26 6s. 6d.; South Zone, £26 9s. 0d.

* **Hematite.**—Si less than 2 per cent, S. & P. over 0.03 to 0.05 per cent., 10-ton lots or over: N.-E. of England (local iron), £23 19s. 0d.; Scotland (Scotch iron), Zone S.1, £24 5s. 6d.; Sheffield, £25 9s. 0d.; Birmingham, £25 13s. 0d.; South Wales (Welsh iron), £23 19s. 0d.

* **Basic Pig-iron.**—£20 3s. 0d., delivered Staffs, Derbyshire, Notts, Lincs, Rutland, Northants, and Leicestershire in 10-ton lots or over.

FERRO-ALLOYS

(per ton unless otherwise stated, delivered)

Ferro-Silicon (6-ton lots and over).—45 per cent. Si, £45 0s. 0d. to £48 0s. 0d., scale 15s. 0d. per unit, lumpy, 75 per cent. Si, £62 10s. 0d. to £66 10s. 0d., scale 15s. 0d. per unit, lumpy.

Ferro-vanadium.—50/60 per cent., 22s. 6d. per lb. of V.

Ferro-molybdenum.—65/70 per cent., carbon-free, 14s.1d. per lb. of Mo.

Ferro-titanium.—20/25 per cent., 2-3 per cent. Cu, £250 0s. 0d.; 38/40 per cent., commercially carbon-free, £287 0s. 0d.

Ferro-tungsten.—80/85 per cent., 10s. 3d. per lb. of W.

Tungsten Metal Powder.—98/99 per cent., 13s. 3d. per lb. of W.

Ferro-chrome (6-ton lots and over, lumpy).—4/6 per cent. C, £80 10s. 0d. to £84 10s. 0d., basis 60 per cent. Cr scale 27s. 0d. to 28s. 6d. per unit; over 6 per cent. C, £79 0s. 0d. to £82 10s. 0d., basis 60 per cent. Cr, scale, 27s. 0d. to 28s. 6d. per unit; 2 per cent. C,* 1s. 8d. to 1s. 11d. per lb. Cr; 1 per cent. C,* 1s. 8d. to 1s. 11½d. per lb. Cr; 0.15 per cent. C,* 1s. 9½d. to 2s. 0½d. per lb. Cr.; 0.10 per cent. C,* 1s. 9½d. to 2s. 0½d. per lb. Cr; 0.06 per cent. C,* 1s. 10½d. to 2s. 1d. per lb. Cr. * Average 68-70 per cent.

Metallic Chromium.—98/99 per cent., 6s. 10d. per lb.

Metallic Manganese.—94/96 per cent., carbon-free, £275 0s. 0d.; 96/98 per cent., £285 0s. 0d.

Ferro-columbium.—65/67 per cent. Cb + Ta, 19s. 0d. per lb., Cb + Ta.

Ferro-manganese (Standard).—78 per cent., £58 10s. 0d.

SEMI-FINISHED STEEL

* **Re-rolling Billets, Blooms, and Slabs.**—BASIC: Soft u.t., 100 tons and over, £31 15s. 0d.; tested, 0.08 to 0.33 per cent. C, 100 tons and over, £32 5s. 0d.; hard (0.41 to 0.60 per cent. C), 50 tons and over, £33 17s. 0d.; silico-manganese, 50 tons and over, £42 16s. 6d.; free-cutting, 50 tons and over, £35 4s. 6d. SIEMENS MARTIN ACID (50 tons and over): Up to 0.25 per cent. C; £40 11s. 0d.; silico-manganese, £43 4s. 0d.

* **Billets, Blooms, and Slabs for Forging and for Stamping** 50 tons and over).—BASIC: Soft, up to 0.33 per cent. C, £37 0s. 0d.; basic, hard, over 0.41 up to 0.60 per cent. C, £38 2s. 6d.; acid, up to 0.25 per cent. C, £41 14s. 0d.

FINISHED STEEL

* **Heavy Plates and Sections** (50 tons and over).—Ship plate (N.-E. Coast), £40 7s. 0d.; boiler plates (N.-E. Coast), £42 17s. 0d.; floor plates (N.-E. Coast), £41 16s. 0d.; angles (N.-E. Coast), £38 1s. 6d.; joists (N.-E. Coast), £37 17s. 6d.

* **Small Bars, Sheets, etc.**—Rounds and squares, under 3 in., and flats 5 in. wide and under, untested soft basic, 50 tons and over, £39 1s. 0d.; under 10 tons to 4 tons, £40 18s. 6d.; under 4 tons to 2 tons, £41 3s. 6d.; hoop and strip, coils, 100 tons and over, £38 0s. 0d.; uncoated strip mill coils, hot rolled, under 3 mm. to 12g., 25 tons to under 50 tons, £43 16s. 0d.; black sheets (hand mill), 24g., 10 tons and over, £57 14s. 6d.; galvanized corrugated sheets, 24g., 10 tons and over, £67 4s. 0d.

Alloy Steel Bars.—1 in. dia. and up: Nickel, £87 16s. 0d.; nickel-chrome, £100 18s. 0d.; nickel-chrome-molybdenum, £113 11s. 0d., in lots of 25 tons and over.

NON-FERROUS METALS

Copper.—Cash, £233 0s. 0d. to £233 10s. 0d.; three months, £236 10s. 0d. to £236 15s. 0d.; settlement, £233 10s. 0d.

Copper, Tubes, etc.—Solid-drawn tubes, 2s. 2½d. per lb. rods, 246s. 0d. per cwt. basis; 20 s.w.g., 281s. 0d. per cwt.

Tin.—Cash, £940 0s. 0d. to £941 0s. 0d.; three months £952 0s. 0d. to £953 0s. 0d.; settlement, £941 0s. 0d.

Lead (Refined Pig).—First half September, £64 2s. 6d. to £64 5s. 0d.; first half December, £65 15s. 0d. to £65 17s. 6d settlement, £64 5s. 0d.

Zinc.—First half September, £74 7s. 6d. to £74 10s. 0d.; first half December, £75 7s. 6d. to £75 10s. 0d.; settlement, £74 10s. 0d.

Zinc Sheets, etc.—Sheets, 15g. and thicker, all English destinations, £113 12s. 6d.; rolled zinc (boiler plates), all English destinations, £111 7s. 6d.; zinc oxide (Red Seal); d/d buyers' premises, £92 10s. 0d.

Brass Tubes, etc.—Solid-drawn tubes 1s. 9½d. per lb.; sheets to 10 w.g., 198s. 9d. per cwt.; wire, 2s. 8½d.; rolled metal, 198s. 9d. per cwt.

Brass (Brazing).—BS1400, B3, £178; B6, £225.

Brass (High Tensile).—BS1400, HTB1, £196; HTB2, £215; HTB3, £230.

Gunmetal.—BS1400, LG2, £220; LG3, £231; G1, ½% £304; G1, 1%, £293.

Phosphor Bronze.—BS1400, PB1 (AID released), £320; BS1400, 90/10/1, £309.

Leaded Phosphor Bronze.—BS1400, LPB1, £245.

Phosphor Bronze Strip, etc.—Strip, 297s. 3d. per cwt.; wire, 4s. 2½d. per lb.; rods, 3s. 5½d.; tubes, 3s. 5½d.; chill cast bars, solids 3s. 6d.; cored, 3s. 7d. (CHARLES CLIFFORD LIMITED).

Nickel Silver, etc.—Rolled metal, 3 in. to 9 in. wide × 0.056, 3s. 11½d. per lb.; round wire, 10g. in coils (10 per cent.), 4s. 4½d.; special quality turning rod, 10 per cent., ½ in. dia., in straight lengths, 4s. 3½d. All prices are net.

Other Metals.—Magnesium, ingots, 2s. 2½d. to 2s. 3d. per lb.; Antimony, English, 99 per cent., £230 0s. 0d. Quicksilver, ex-warehouse, £63 0s. 0d. Nickel, £660 0s. 0d. Aluminium, ingots, £186 0s. 0d.; aluminium bronze (BS1400), AB1, £245; AB2, £253.

Company News

WOLSELEY-HUGHES, LIMITED, holding company for engineering concerns, of Birmingham—Permission is being sought for London and Birmingham Stock Exchange quotations for the 150,000 6 per cent. preference £1 shares.

NEWMAN, HENDER & COMPANY, LIMITED, manufacturers of bronze, iron, and steel valves, etc., of Stroud (Glos)—Except for those companies dealing with the petroleum industry, all the companies of the group have full order-books and overall output and sales are on the increase, states the chairman, Mr. N. P. Newman.

ARTHUR BALFOUR & COMPANY, LIMITED—Interim dividend of 6 per cent. less income tax has been declared on the 2,091,964 ordinary shares of 10s., payable to holders registered on August 10, in accordance with the terms of the offer by Balfour & Darwins, Limited, dated July 14, 1961, and now unconditional.

GEORGE H. SCHOLES & COMPANY, LIMITED, electrical engineers, of Wythenshawe, Manchester—Net profit for the year to June 30, 1961, was £215,000, compared with £202,000, after tax of £234,000 (£190,000). A final dividend of 22½ per cent. makes an unchanged total for the year of 27½ per cent. It is proposed to make a scrip issue of one for five.

FURNESS, WITHY & COMPANY, LIMITED, shipowners, etc., of Newcastle-upon-Tyne—Group profit on ships' trading and other business, after contingencies, and, in the case of a subsidiary, special depreciation on new tonnage, was £4,400,000 (£4,700,000). Depreciation took £3,600,000 (£3,200,000) and with the maintained 10 per cent. dividend, the group net profit was £1,300,000 (£1,800,000).

WILMER LEA FOUNDRIES (HOLDINGS), LIMITED—At last week's extraordinary meeting holders approved the acquisition of Charles Karen & Son (Holdings), Limited, group, and John Batt & Company (London), Limited, together with eight non-trading companies, consolidating the 1s. shares into 5s. shares increasing the capital to £500,000, amending the articles and changing the name of the company to C.K.S. Group United Metals, Limited.

BRAITHWAITE & COMPANY, ENGINEERS, LIMITED, constructional engineers, of London, S.W.1—The structural order-book is now in a much healthier condition and while prices remain very keen a period of full production can be looked forward to at the West Bromwich and Newport works, says Mr. J. Harvey Humphreys, chairman. The board now feels that the tide has turned and that a steady improvement can confidently be expected. In the year ended March 31, 1961, the group incurred a net loss of £37,710, compared with a previous profit of £45,706.

BORAX (HOLDINGS), LIMITED, announce that its American operating company, United States Borax & Chemical Corporation, has entered into a joint venture with Homestake Mining Company, of San Francisco, California, to complete studies relating to possible potash production in Saskatchewan, Canada, where U.S. Borax has been investigating permits held since 1957. If the completed studies indicate the technical and economic feasibility of a large Canadian potash operation, the two companies may participate equally in any company formed for such purpose. One or more additional associates may also be invited to participate in the future.

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Personal

Mr. I. M. MACLAY has resigned from the board of the Prestige group.

Mr. MAURICE BIDDULPH, technical manager, has been appointed technical director of Universal Metal Products, Limited.

Mr. J. P. M. FERRIER has been co-opted to the board of Fairbairn Lawson Combe & Barbour, Limited, as an additional director.

Mr. W. T. VIZER-HARMER is retiring from the board of the Steel, Peech & Tozer branch of the United Steel Companies, Limited, at the end of the year.

Mr. ROBERT BUTLER, previously a director of Quasi-Arc, Limited, has been appointed managing director of Eutectic Welding Alloys Company, Limited.

Mr. V. C. FAULKNER, Editorial Director of the FOUNDRY TRADE JOURNAL, has been made a service life member of the American Foundrymen's Society.

Brook Motors, Limited, Huddersfield, announce that Mr. JAMES B. FLYNN, who joined the company in 1951 as an apprentice, has been appointed to the sales staff of their Plymouth office.

Mr. LAWRIE DALE, chief storekeeper, Hadfields, Limited, Sheffield, retired on August 31 after 40 years' service with the firm. Colleagues presented him with a gold watch to mark the occasion.

Mr. A. J. N. BROWN, a past-president of the Association of Bronze & Brass Founders, has retired from the Council of the Association as he has relinquished his post on the staff of a member company.

Mr. C. S. JARRETT and Mr. H. J. T. WING, secretaries, respectively, of the Austin Motor Company, Limited, and Morris Motors, Limited, have been appointed local directors of those companies.

Mr. KENNETH STEPHEN BRADSHAW, Birmingham branch manager of Cox & Danks, Limited, a company in the Metal Industries group, has been appointed Cox & Danks' Midlands director based in Birmingham.

Mr. A. C. BAUL, London branch manager; Mr. E. A. ELLERTON, commercial manager; and Mr. A. M. TAYLOR, secretary, have been appointed to the board of Foster Electrical Supplies, Limited, a member of the Metal Industries group.

Mr. H. MORROGH, director of the British Cast Iron Research Association, is to address the members of the (American) Gray Iron Founders' Society at their 33rd annual meeting which is to be held in Toronto between October 18 and 20.

Dr. G. G. MACFARLANE, at present deputy director of the National Physical Laboratory of the Department of Scientific and Industrial Research, is being appointed director of the Royal Radar Establishment at Malvern (Worcs). He will take up his new duties early next year.

Edgar Allen & Company, Limited, announce that Brigadier A. LEVESLEY, O.B.E., M.C., T.D., M.I.MECH.E., a director of the company, has accepted the chairmanship of the Sheffield Standing Conference of Voluntary Youth Organizations in succession to the former Chief Constable of Sheffield, Mr. G. E. Scott, O.B.E.

Mr. JAMES ANDERSON, since 1945 chief metal buyer at the Latchford, Warrington, works of the British Aluminium Company, Limited, has retired after 50 years' service with the company. He joined the firm as an apprentice in 1911, and before his appointment as buyer was for some years casting shop superintendent.

Mr. A. F. CATTELL, B.SC., of Coatbridge, has been appointed chief engineer at the Caterpillar Company's plant at Grenoble in the French Alps. He joined the company in 1957 as a design engineer, and was promoted design supervisor a year later, subsequently becoming general supervisor for crawler-tractor design. He leaves for Grenoble this month.

Mr. DAVID G. ELIAS, general manager of Simon-AMF, has been appointed a director of the company. Mr. GORDON O. FRASER has been appointed New York director and Mr. JOHN M. MELLOR becomes commercial director. Simon-AMF is a joint company of American Machinery & Foundry Company of the US and Henry Simon and was incorporated in January.

Mr. C. B. MCNAIR, general manager of Stewarts and Lloyds' tube works at Coombs Wood, Halesowen (Worcs), retired last Thursday owing to ill health. He is succeeded by Mr. W. H. CRAWFORD, general manager of the company's tube works at Corby, Northants, who is now in charge of both works. Mr. E. J. WHITFIELD, works manager at Coombs Wood, becomes assistant general manager.

SIR HENRY W. SMITH, chairman, Mr. A. J. MARR and Mr. R. C. THOMPSON, directors of Sunderland Shipbuilding Dry Docks and Engineering Company, Limited, have been appointed additional directors of William Doxford & Sons. Sir Henry has been appointed vice-chairman. Mr. G. C. L. THOMPSON and Mr. R. P. KEY have resigned from the board of William Doxford.

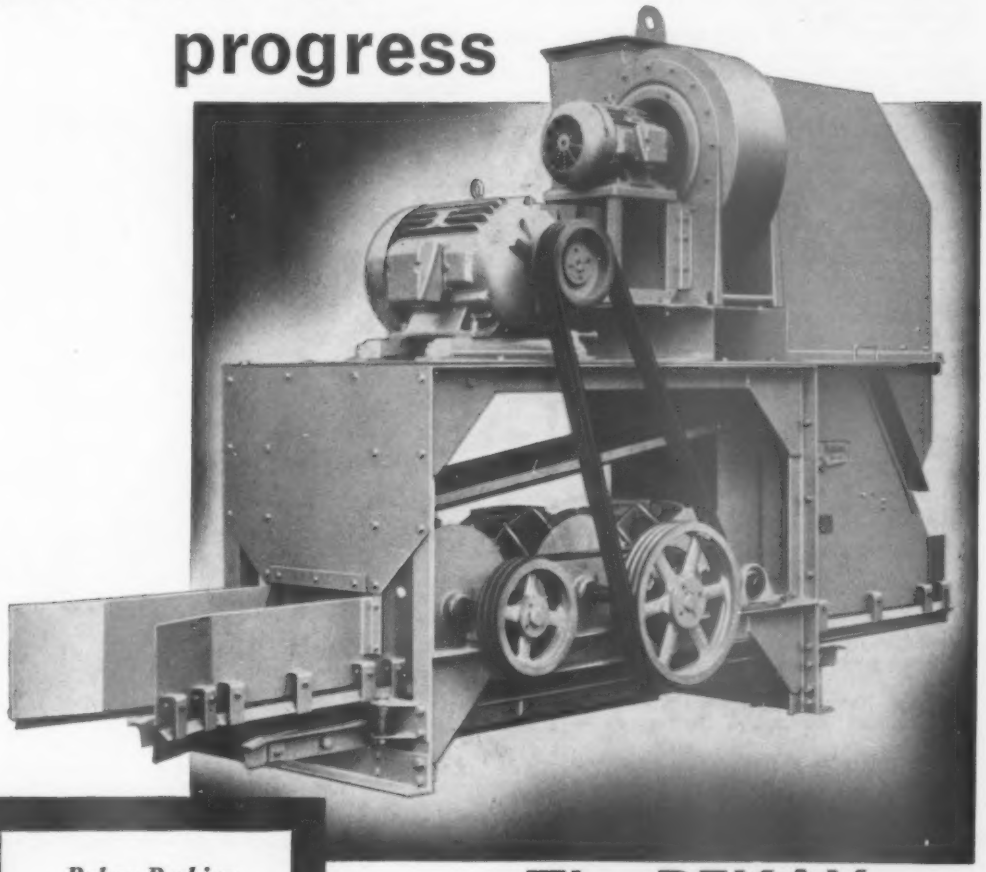
The EARL OF VERULAM has been appointed chairman of Delta-Enfield Rolled Metals, Limited. Mr. C. C. MILLAR has been appointed vice-chairman and Mr. A. LANE becomes managing director. Other directors are Mr. W. W. DOLTON, Mr. S. POWELL and Mr. W. J. VAUGHTON. Mr. W. W. RIGG is company secretary. The company was formed earlier this year when Enfield Rolling Mills, Limited, and the Delta Metal Company, Limited, merged their rolled-copper and brass-sheet and strip interests.

Vickers-Armstrongs (Engineers), Limited, Barrow-in-Furness, have appointed Mr. R. F. W. KEAY an additional member of the board and director of production engineering, and Mr. J. HAY a special director and works manager of the Barrow Engineering works. Mr. Keay, who started with the company as an apprentice, is at present a special director and Barrow engineering works manager. He is also a director of Robert Boby, Limited, Bury St. Edmunds. Mr. Hay, who has been assistant engineering works manager at Barrow since 1957 has held various positions with the company.

ABBF—London-area Meeting

The Association of Bronze and Brass Founders report that it has been decided to postpone the meeting of London-area members provisionally arranged for September 13 until the time of the Engineering Materials and Design Exhibition (November 13 to 18). It is then proposed to hold a one-day Foundry/User Conference which, in conjunction with the Exhibition, should prove of great value in the Association's sales-promotion campaign for copper-alloy castings. Details of arrangements will be published in due course, in the meantime, it is suggested that members should consider the designers, buyers and customers they will wish to invite to attend the conference.

pattern for progress



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Foundry Machinery Department, Bedewell Division, Hebburn-on-Tyne, Co. Durham. Tel. Jarrow 897124
B.P.F. 14

Publications Received

Steel Review, No. 23. Published by the British Iron and Steel Federation, Steel House, Tothill Street, London, S.W.1.

The reviewer was specially attracted by two articles in this issue. One was "British Steel in Moscow" in which is given an account of the recently held Trade Fair in Moscow by a representative from the British Iron and Steel Federation who actually served on the Federation's stand. It is a factual and interesting article. in that it reveals the attitudes of both the Russian officials and the "man-in-the-street" to the British as individuals and the effort they put forward in the industrial field. The second article, on the United States' steel trade, is distinctly thought-provoking, as steel consumption in America is lagging behind the country's total industrial output. The author, whilst not drawing a direct comparison between Europe and America, does pose the question whether such conditions may come about in the UK, quoting some factors common to both countries.

Report on the Recruitment and Training of Technicians. By the Federation (also issued from the address quoted above).

Bravely, this report has given a definition of a technician. It is rather wordy and the introduction of the phrase to qualify technical practices "that have been defined by technologists," is unnecessary as some of these practices have been handed down through the years. Yet the general wording of the defiinition does give an excellent appreciation of what a technician is and does. A routine chemist would not qualify for the grade, but a works chemist not engaged on routine work would—a quite logical viewpoint. This publication will be very useful to the foundry industry as it, too, is at the moment engaged in considering analogous problems.

Federated News, July 1961. Issued by Federated Foundries, Limited, 4, Stratford Place, London, W.1.

This publication is prepared in newspaper style, and the main emphasis in this special issue about the company's Sofono products, is on solid-fuel appliances, and new products such as infra-coal and infra-log fuel-effect fires. Also included is some useful information about central heating and smokeless zones, and one article deals with the expansion at Grange-Camelon Iron Company, Limited, in Scotland, following the company's entry into the domestic-electric-appliance market.

Sif-Tips, Vol. 26, No. 12. Published by the Suffolk Iron Foundry (1920), Limited, Stowmarket.

This issue notifies readers of a double change. The original Editor, after an absence of several years, has returned to his chair and has decided to replace "Will-the-Welder" senior by his junior namesake in reporting welding hints. Sif-Tips is the one welding magazine of special interest to founders as it quite often deals with the repair of broken castings.

Boat Building by Yarecraft, Technical Notes No. 224. Published by CIBA (A.R.L.), Limited, Duxford, Cambridge.

Not a few master patternmakers interest themselves in the newer methods of dinghy building and these will find of real interest this illustrated description of the making of hulls from cold-moulded plywood bonded with Aerolite 300.

Catalogues

Steel Castings. Stewarts and Lloyds, Limited, Brook House, Upper Brook Street, London, W.1, have issued a brochure (Ref. S-L 874) covering in 42 pages an illustrated description of their Tollcross Foundry, near Glasgow. At the moment, this steel foundry is well to the forefront in the production of artistic trade literature and is an example to other sections of the industry, though here and there an outstanding publication does appear in this field. The art side of this booklet includes a number of coloured illustrations which do credit to modern printing. The description of the foundry is concise, and fulfills the purpose of impressing upon the reader that rigid control is imposed upon every manufacturing department and that new methods are being used to enhance quality. This is well revealed by comparing the description of the Tollcross Foundry by Mr. A. R. Parkes, which appeared in the June 17, 1957, issue of the JOURNAL, with this new publication, where there are several references to the use of quick-setting cores and facing sands. Another innovation is the extraction of dust, from moulds ready for closing, by suction instead of blowing. It is obvious that the £1,000,000 spent on building and equipping this foundry has been well spent and that technical progress is constantly being made.

The brochure carries a series of pictures of the castings currently in production and incorporates additional information of direct use to the buyer, such as specifications and the like.

Magnetic Separators. Four types of magnetic separators are described in the recently revised Technical Description, No. 315, now available from the General Electric Company, Limited, Witton, Birmingham, 6. These are—pulley or drum type; suspension, chute, and stand-type swarf separators. The information contained in the previous publication has been brought up to date and particulars of a new range of magnetic separator pulleys have been included.

Machinery Catalogue, No. 1077. Issued by Thos. W. Ward, Limited, Albion Works, Sheffield.

This six-monthly publication has been embellished with a photograph, extending from front to back cover, of the company's Sheffield showroom. The booklet carries seven sections ranging from machine-tools to electrical plant. Many of the items offered are illustrated. It is indeed a useful catalogue for any buyer to have in his office.

Electrode Salt-bath Furnaces. A range of electrode salt-bath furnaces, mainly used for various types of heat-treatment, are dealt with in publication No. R1 (661) issued by Efco Furnaces, Limited, Queens Road, Weybridge, Surrey. At one time there seemed to be some prospect of the use of these furnaces for malleabilizing cast iron, but no important application of the process has been reported.

Paddle-bladed Fans. In publication No. 2605, which supersedes No. 2604, the Sturtevant Engineering Company, Limited, Southern House, Cannon Street, London, E.C.4, describe and illustrate their D range of fans for dust and fume extraction for such equipment as foundry fettling tables and rumblers.

Stock-control Aids. A leaflet received from KABI (Electrical and Plastics), Limited, Cranborne Road, Potters Bar, Middlesex, describes, lists and prices, a range of "Presson" self-adhesive label holders and "Gripson" self-sticking stock markers.

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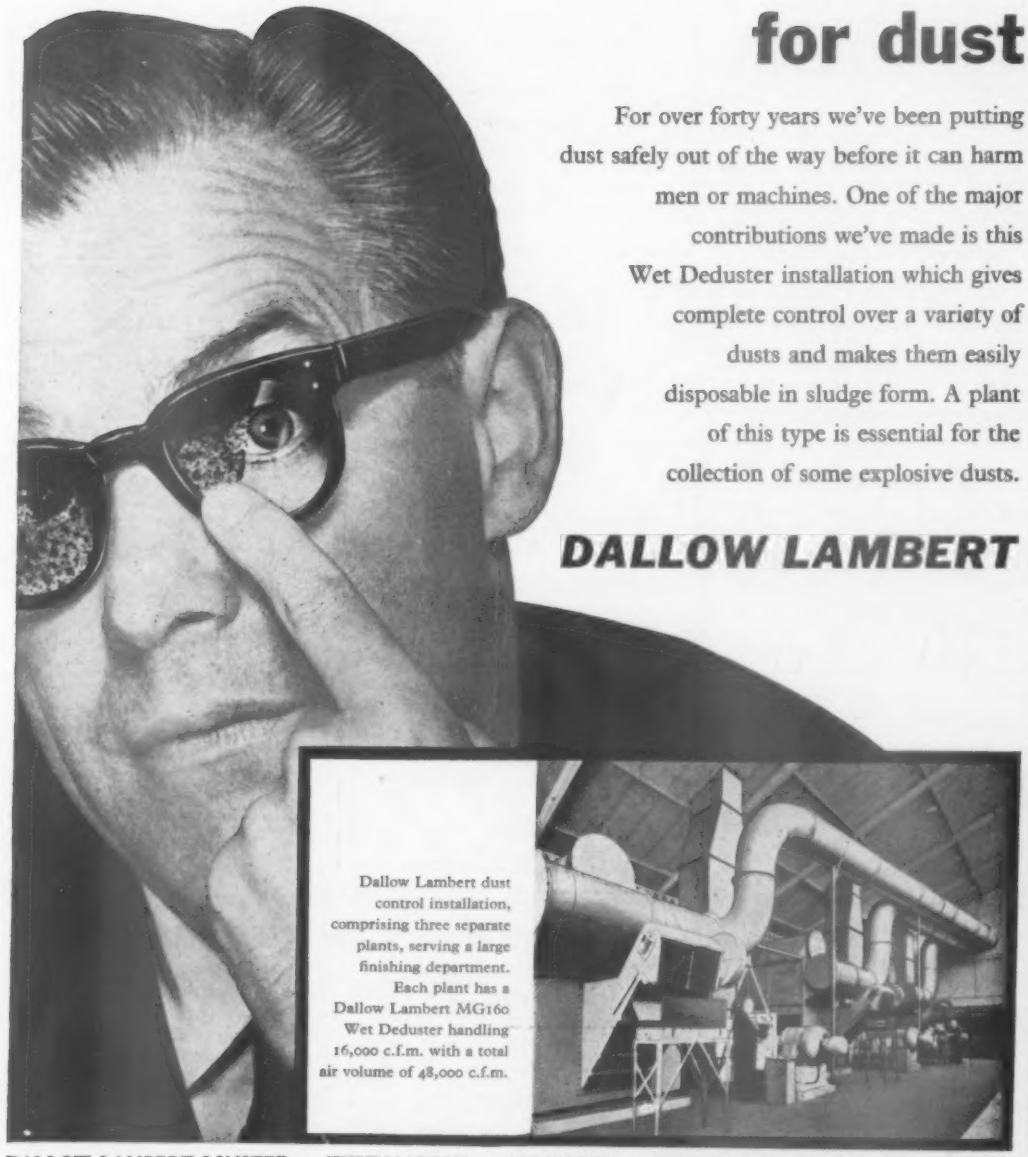

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METALLURGIST, 43, F.I.M., M.I.B.F., earning £2,000 p.a., seeks executive position with small firm. Wide knowledge and experience of metallurgy of cast iron, iron and steelmaking. Box MF905, FOUNDRY TRADE JOURNAL.

FOUNDRY MANAGER (31), H.N.C., National Foundry College Diploma, desires new appointment with reputable company preferably in South or South Midlands. Able to work on own initiative. Thorough knowledge of most modern processes. Box FM937, FOUNDRY TRADE JOURNAL.

SITUATIONS VACANT

EXPERIENCED PROJECT DRAUGHTSMEN required for a Foundry Consultant drawing office in the Epsom area. Mechanical handling experience is essential. Age range 25-35 years. Salary offered commensurate with experience. Apply: PROJECT MANAGER, FOUNDRY MANAGEMENT & DESIGN CO. LTD., 4, Downside, Epsom, Surrey.

SALES REPRESENTATIVE

A modern mechanised Foundry in the North Midlands requires a representative for the United Kingdom to sell grey iron castings. This position offers scope and excellent prospects to the right applicant.

Applications stating experience, age and salary required to:

Box SR. 938
Foundry Trade Journal

PROGRESSIVE Investment Casting Company in the United States of America requires EXPERIENCED PROCESS ENGINEER. Applicant should have experience in gating, casting and ceramic shell techniques, salary commensurate with qualifications and experience. Reply stating age, qualifications and experience to BOX PI921, FOUNDRY TRADE JOURNAL.

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SITUATIONS VACANT—*contd.*

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FOUNDRY METALLURGIST, experience in malleable and grey iron, furnace and sand control. Must have good foundry experience and take charge laboratory. Situate West Midland area. Box FM903, FOUNDRY TRADE JOURNAL.

ASSISTANT FOREMAN for Grey Iron Foundry in Birmingham Area on jobbing and batch production up to 20 cwts. Experience on Sand Control and modern foundry procedure. Position offers excellent prospects to young man possessing drive and initiative. Box AF914, FOUNDRY TRADE JOURNAL.

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TECHNICAL SALES REPRESENTATIVE. Opportunity occurs in Company specializing in High Quality Grey Iron Castings, mainly for Shell Moulding, also Sand Castings. Would be willing to train suitable applicant, who should have engineering and foundry experience, and must have pleasing personality, possess initiative, and have confidence to make fresh contacts in a competitive market. Full details, in confidence, of age, experience and salary required, also date when available, to Box TS930, FOUNDRY TRADE JOURNAL.

AN ASSISTANT

is required by the Works' Manager of a rapidly expanding Grey Iron Foundry Group in the West Midlands. Applicants must be experienced foundrymen with the ability to assume full control of a mechanised unit capable of producing in excess of 150 tons per week.

This vacancy offers excellent opportunities for promotion to a man of initiative and a high salary commensurate with experience and ability is offered.

Apply giving full details to BOX AA 936, FOUNDRY TRADE JOURNAL.

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We invite applications for this position, carrying full responsibility for all activities in a modern mechanised foundry producing Blackheart malleable castings. Applicants must have held a post with a similar level of responsibility, but not necessarily in a malleable foundry. Salary will be appropriate to such experience, and carries a generous Pension Scheme and Life Assurance. Confidential applications to:—

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SITUATIONS VACANT—contd.

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FOREMAN required for non-ferrous jobbing foundry, situated in Surrey, making castings up to 4 cwt. Write stating age, and giving full details of experience and salary required, to Box FR940, FOUNDRY TRADE JOURNAL.

PRACTICAL MAINTENANCE ENGINEER, preferably with some administration experience, for small iron foundry in North Staffordshire. Interesting position with prospects for ambitious person willing to co-operate with Director on production planning, etc. Scope for travel if interested. We are NOT looking for a man who wishes to remain purely a maintenance engineer. Genuine applications only, in confidence, stating fullest details of experience. Box PM929, FOUNDRY TRADE JOURNAL.

CHIEF INSPECTOR required by a firm of Non-ferrous Founders situated in the South Wales area. Must be fully experienced in inspection procedures and practices, control of labour and A.I.D. approved. The position is permanent and a generous salary will be paid. Apply in confidence, stating age, brief details of experience and salary required, to Box C1934, FOUNDRY TRADE JOURNAL.

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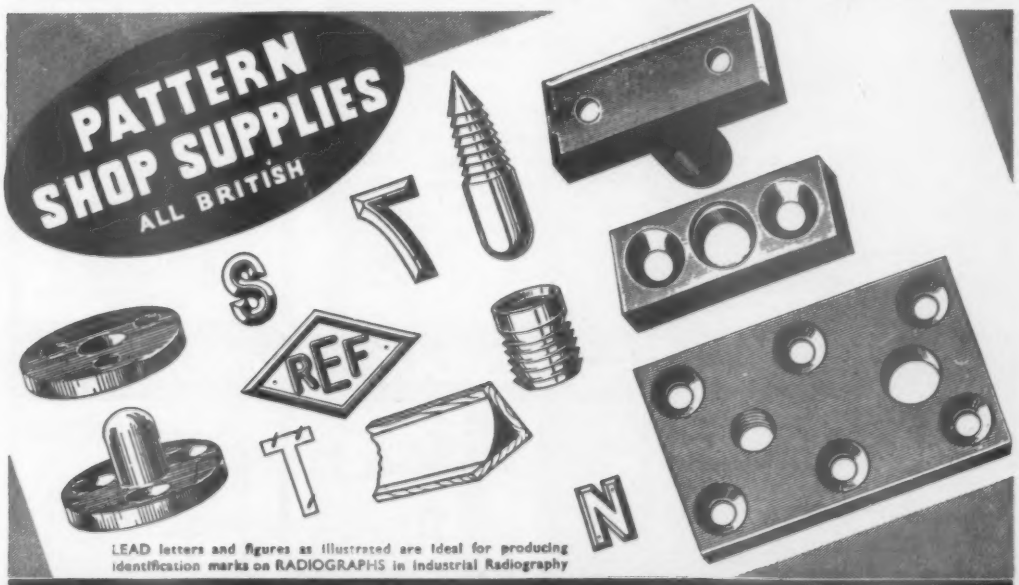

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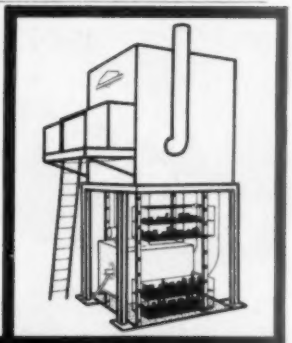

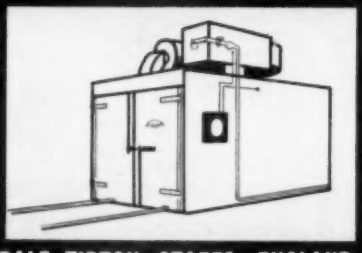

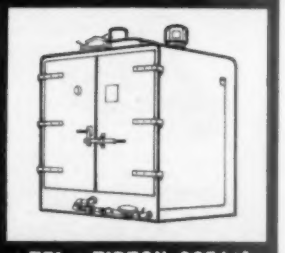

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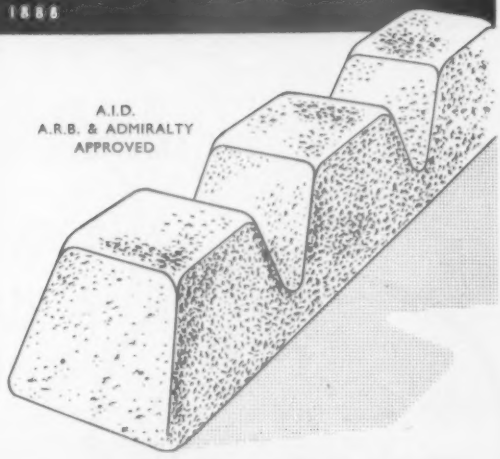

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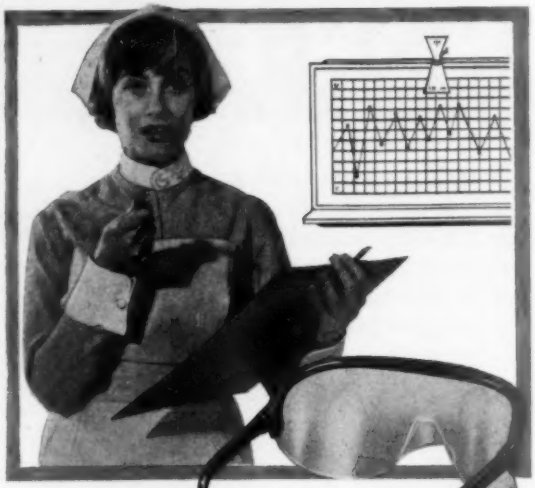

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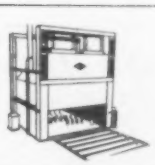

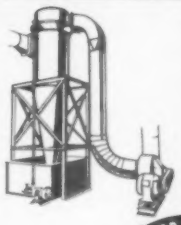

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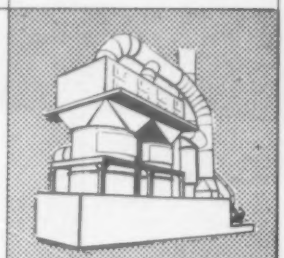

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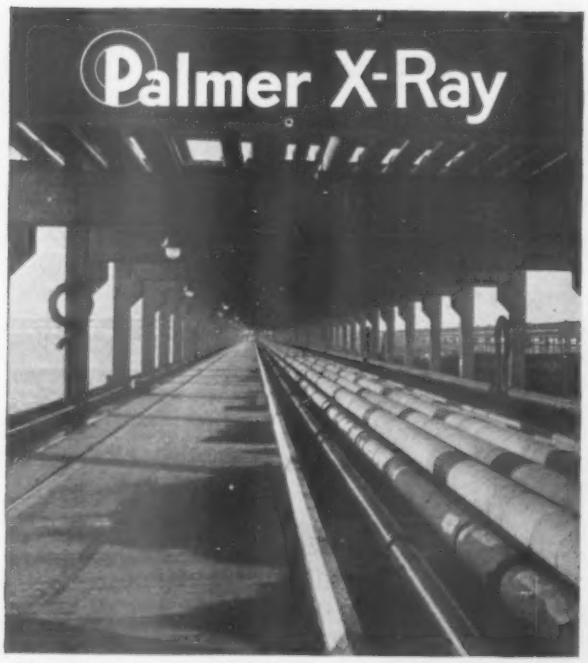

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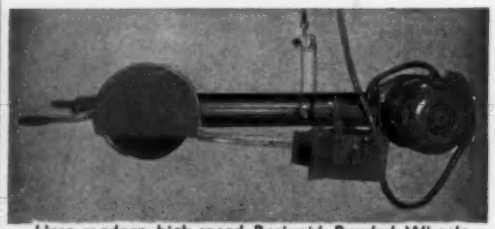

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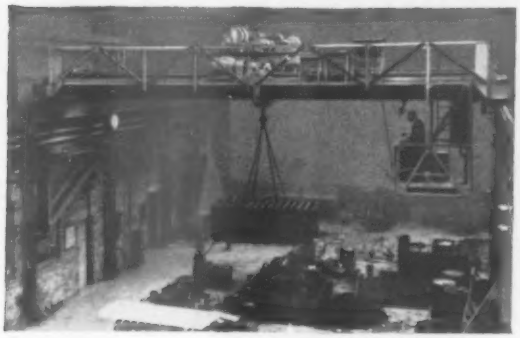

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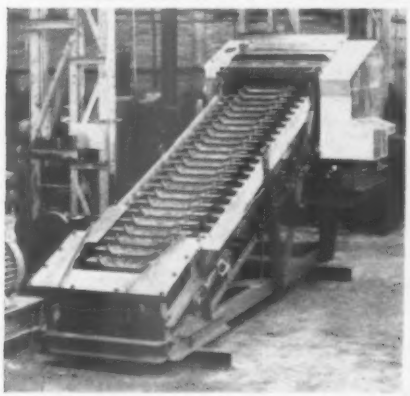

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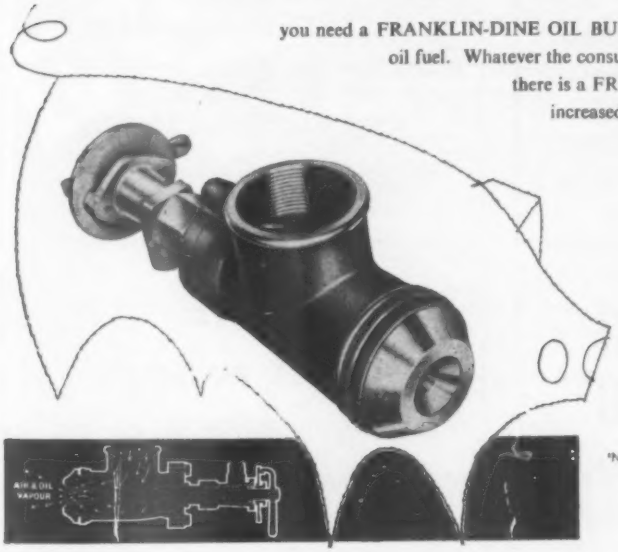

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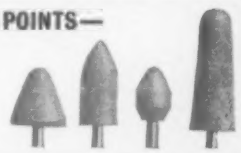

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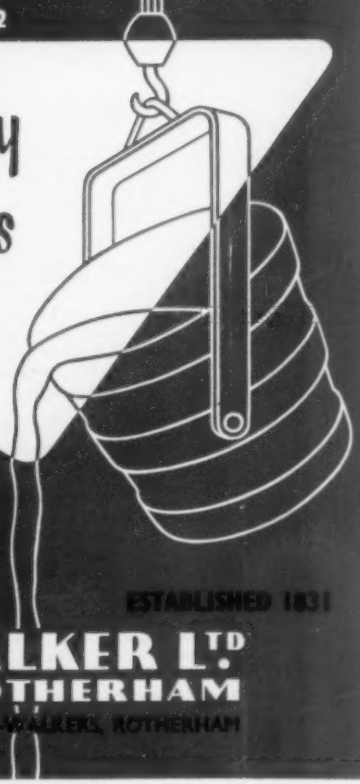

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